THE ACHILLES’ HEEL OF HEMODIALYSIS: THE VASCULAR ACCESS

GERALD SCHULMAN MD
PROFESSOR OF MEDICINE
VANDERBILT UNIVERSITY SCHOOL OF MEDICINE
NASHVILLE, TN
THE DEATH OF ACHILLES
HEMODIALYSIS ACCESS OPTIONS
“In my opinion, probably the most important contribution to long term survival of hemodialysis patients.” S. Shaldon

Brescia MJ, Cimino JE, Appel K, Hurwich BJ Chronic hemodialysis using venepuncture and a surgically created arterio-venous fistula. NEJM 1966;275;1089

Courtesy of S. Shaldon
VASCULAR ACCESS OPTIONS:
PRIMARY ARTERIO-VENOUS FISTULA (AVE)

• ANATOMIC DESCRIPTION

• TYPES:
  ✗ RADIAL-CEPHALIC
    (CIMINO-BRESCIA)
  ✗ RADIAL-CEPHALIC
    (SNUFF-BOX)
  ✗ BRACHIAL-
    CEPHALIC
    (ABOVE ELBOW)
  ✗ BRACHIAL-BASILIC
    (TRANSPOSED)
Vascular Access Options: 
Arterio-venous Grafts (AVG)

• Anatomic Description:

• Types:
  - PTFE, ePTFE, Diastat…”

- Material
- Distribution
  - Brachial-cubital fossa (loop)
  - Radial-cubital fossa (straight)
  - Radial-brachial (straight)
  - Brachial-brachial (loop)
  - Brachial-axillary (straight)
  - Femoral-saphenous (loop)
  - Femoral-femoral (loop)
  - Iliac-femoral (loop)
  - Axillary-axillary
Vascular Access Options: B- Arterio-venous Grafts (AVG)

• Anatomic Description:
• Types:

　Material
- PTFE, e-PTFE, Diastat…

　Distribution
- Brachial-cubital fossa (loop)
CATHETERS

- SITES:
  - RIGHT IJV (+++)
  - LEFT IJV (AVOID)
  - LEFT & RIGHT SCV (AVOID except obese)
  - LEFT & RIGHT FV
  - SUPRA-CLAVICULAR (LATERAL)
  - SUPRA-CLAVICULAR (RAO)
  - TRANS-LUMBAR (IVC)
  - TRANS-RENAL
  - TRANSHEPATIC !!
CATHETERS AND IMPLANTS

- TEMPORARY
- PERMANENT:
  - TUNNELED CATHETERS:
    - TESIO® (MEDCOMP)*
    - PERM-CATH® (QUINTON)*
    - VASCATH SOFT-CELL® (BARD)*
    - ULDALL-COOK® (COOK)
    - TWIN-CATH® (MEDCOMP)
    - DUAL-CATH® (HEMOTEC)

  - IMPLANTABLE CHAMBERS:
    - DIALOCK® (BIOLINK)
HEMODIALYSIS ACCESS COMPLICATIONS

- COMPLICATIONS DUE TO ACCESS PLACEMENT PRACTICES
- COMPLICATIONS DUE TO COST
- COMPLICATIONS DUE TO MEDICAL PROBLEMS
- INTERVENTIONS TO IMPROVE OUTCOMES
HEMODIALYSIS ACCESS COMPLICATIONS

• COMPLICATIONS DUE TO ACCESS PLACEMENT PRACTICES
• COMPLICATIONS DUE TO COST
• COMPLICATIONS DUE TO MEDICAL PROBLEMS
• INTERVENTIONS TO IMPROVE OUTCOMES
I- MAGNITUDE OF THE PROBLEM:

• INCREASING END-STAGE RENAL DISEASE (ESRD) POPULATION
• MORBIDITY RELATED TO VASCULAR ACCESS (VA)
• INCREASING COSTS
• PLACEMENT OF POLYTETRAFLUOROETHYLENE (PTFE) GRAFTS
• LATE REFERRAL TO THE NEPHROLOGIST & PLACEMENT OF TEMPORARY ACCESSSES
• LACK OF ACCESS MONITORING PROGRAMS
FREQUENCY OF PRE-ESRD PLACEMENT OF PERMANENT DIALYSIS ACCESS IS SUB-OPTIMAL

Held, AJKD 1996, 28 (SUPPL. 2):58-78

Permanent Access Placed or Attempted Before ESRD
1,997 patients incident in 1993 (USRDS DMMS Wave 1)
INDICES OF SUB-OPTIMAL PRE-ESRD CARE LACK OF PERMANENT DIALYSIS ACCESS

IFUDU, AJ KD, 28: 841, 1996

<table>
<thead>
<tr>
<th></th>
<th>Temporary Access for First HD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nephrologist</td>
<td>36%</td>
</tr>
<tr>
<td>Non-Nephrologist Pre-ESRD Care</td>
<td>89%</td>
</tr>
<tr>
<td>No Medical Care</td>
<td>100%</td>
</tr>
</tbody>
</table>
MAGNITUDE OF THE PROBLEM: INCREASING ESRD POPULATION

• ESTIMATED GROWTH RATE: 6-7%/YEAR

• INCIDENCE: 268/ M POP./ YR (HIGHEST AGE 70-74)

• PREVALENCE: 1041/ M POP./ YR (HIGHEST AGE 65-69)
ACCESS PRACTICE AND ITS IMPLICATIONS ON SURVIVAL
MAGNITUDE OF THE PROBLEM: HIGH MORBIDITY RELATED TO VA

- VA RELATED PROBLEMS ACCOUNTS FOR 25% OF HOSPITAL ADMISSIONS IN THE ESRD POPULATION**
- HIGHER MORBIDITY IN FEMALES!*  
- HIGHER IN PATIENTS WITH PTFE AND INDWELLING CATHETERS**
- LATE REFERRAL TO THE NEPHROLOGIST***
- LINK BETWEEN VA AND DIALYSIS ADEQUACY

Dialysis Outcomes and Practice Patterns Study

Vascular Access: Results from the DOPPS
DOPPS II

(randomly selected sites stratified by unit type and region)

Japan
(60 facilities)

Europe
(140 facilities)

Canada & US
(120 facilities)

Australia & New Zealand
(20 facilities)
Prevalent patients in the US with permanent vascular access. The adjusted odds ratio (graft vs. fistula), percentage graft use, and P value are listed for each region. The odds ratio is adjusted for age, sex, diabetes, and peripheral vascular disease. The reference group was the overall national average, assigned an AOR of 1.0.

Odds ratio = G/F [G%] (p-value)

1.37 [74%] (ns)
0.88 [65%] (ns)
0.65 [59%] (ns)
0.90 [70%] (ns)
0.44 [53%] (<0.01)
1.33 [79%] (ns)
1.97 [82%] (<0.01)
0.38 [51%] (<0.05)
0.90 [70%] (ns)
1.00 [72%] (ref group)

Vascular Access
Use
Vascular Access Use, by Country Among Prevalent HD Patients

**Preliminary DOPPS II results as of Sept. 2003**
AV Fistula Use In 3 Prevalent HD Patient Subgroups: EUR and US

Without diabetes, peripheral vascular disease, and coronary artery disease

With diabetes, peripheral vascular disease, and/or coronary artery disease

AV Fistula (%)

<table>
<thead>
<tr>
<th></th>
<th>EUR</th>
<th>US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male, age 18-54 yrs</td>
<td>89</td>
<td>41</td>
</tr>
<tr>
<td>Female, age 18-54 yrs</td>
<td>76</td>
<td>22</td>
</tr>
<tr>
<td>Male, age &gt;54 yrs</td>
<td>82</td>
<td>22</td>
</tr>
<tr>
<td>Female, age &gt;54 yrs</td>
<td>64</td>
<td>10</td>
</tr>
</tbody>
</table>

DOPPS I: 1997-98

Distribution of AV Fistula Use Among Dialysis Facilities in EUR and the US

Facilities (%)

US
(median = 21%)

EUR
(median = 83%)

0
20
40
60
80
100

% AVF Use Within a Facility

10th %ile
25th %ile
75th %ile
90th %ile

Vascular Access Use Among Incident HD Patients: DOPPS II

**Preliminary DOPPS II results as Sept. 2003
Incident patients entering DOPPS within 7 days of first-ever chronic dialysis**
Current Patterns of AVF Use by ESRD Network

Source: 2002 CDC Data
Hemodialysis Patients with Graft at Start of ESRD by Census Region, 1993

Hirth et al, JAMA, 1996
Access Procedure Rates Are Much Higher for Grafts versus Fistulae

<table>
<thead>
<tr>
<th>Type of Procedure</th>
<th># Procedures/100 pyrs</th>
<th>Adjusted Relative Proc. Rate (G/F)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Graft</td>
<td>Fistula</td>
</tr>
<tr>
<td>Angiogram</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Angioplasty alone</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Thrombectomy, clot lysis or revision</td>
<td>59</td>
<td>17</td>
</tr>
<tr>
<td>Any VA procedure</td>
<td>74</td>
<td>28</td>
</tr>
</tbody>
</table>

†p<0.05; ‡p<0.0001; * per 100 patient years; G=graft, F=fistula; adjusted for age, gender, diabetes, peripheral vascular disease, and facility clustering effects.
Catheter Use and Outcomes
Catheter Use Associated with High Infection Rates

RR of Infection

<table>
<thead>
<tr>
<th>Catheter Type</th>
<th>RR</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tunneled Catheters</td>
<td>5</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td>Untunneled Catheters</td>
<td>7.8</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td>Fistulae</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

*adjusted for age, gender, continent (EUR vs US), and 15 classes of comorbidities; p values are for comparison to infection rate for fistulae. RR= Risk Ratio

Higher Facility Catheter Use Associated with Increased Mortality Risk (US and Euro-DOPPS-I)

<table>
<thead>
<tr>
<th>Facility Catheter Use, % of patients</th>
<th>RR* of death</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-7</td>
<td>1.00</td>
<td>p=0.27</td>
</tr>
<tr>
<td>7.1-14</td>
<td>1.08</td>
<td>p=0.05</td>
</tr>
<tr>
<td>14.1-21</td>
<td>1.17</td>
<td>p=0.13</td>
</tr>
<tr>
<td>21.1-28</td>
<td>1.13</td>
<td>p&lt;0.01</td>
</tr>
<tr>
<td>&gt;28</td>
<td>1.23</td>
<td></td>
</tr>
</tbody>
</table>

(US)-10% in this group
(US)-50% in this group
Survival Curves for AVF Cannulated Either <14 Days or >14 Days

Relative risk adjusted for age, gender, diabetes, peripheral vascular disease, nephrological care prior to starting dialysis, AVF location in upper versus lower arm, country, and facility clustering effects; patients with prior temporary access excluded; AVF = AV fistula; n=642.

RR of failure if AVF cannulated <14 days versus >14 days = 2.1 (p=0.006)

THERE ARE ONLY TWO TYPES OF CATHETERS: THOSE THAT ARE INFECTED AND THOSE THAT WILL BE INFECTED.
## Odds of Starting HD with Permanent AV Access versus Catheter by 2 Practice Patterns

<table>
<thead>
<tr>
<th>Practice Pattern</th>
<th>Adjusted Odds Ratio (AOR)*</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seen by nephrologist &gt; 1 month prior to ESRD (yes v. no)</td>
<td>6.1</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>VA surgery within ≤ 2 weeks of referral (yes v. no)</td>
<td>1.8</td>
<td>0.002</td>
</tr>
</tbody>
</table>

* AOR adjusted for age, gender, diabetes, PVD, BMI, pre-ESRD care, facility clustering effects; DOPPS I n=2073

HEMODIALYSIS ACCESS COMPLICATIONS

• COMPLICATIONS DUE TO ACCESS PLACEMENT PRACTICES

• COMPLICATIONS DUE TO COST

• COMPLICATIONS DUE TO MEDICAL PROBLEMS

• INTERVENTIONS TO IMPROVE OUTCOMES
INCREASING COST

• TOTAL ESRD SPENDING (1996): $14.55 BILLION ($43,563/ PT-YR AT RISK)

• ACCESS RELATED SPENDING (1994): ≈$1 BILLION, 
  ≈$8000/PT-YR AT RISK

• COST INCREASES WITH PTFE, PARTLY II° TO PROCEDURES NEEDED TO MAINTAIN PATENCY

USRDS 1998
Feldman et al, JASN, 7(4): 523, 1996
ELECTIVE OUTPATIENT VASCULAR ACCESS PLACEMENT COSTS LESS

BLEYER, NEPHROLOGY NEWS AND ISSUES JAN 1995: 19-22

Inpatient: $10,557
Outpatient: $2,990

Setting of Vascular Access Placement
ARTERIOVENOUS GRAFTS ARE MORE LIKELY TO REQUIRE REVISION THAN FISTULAS
HEMODIALYSIS ACCESS COMPLICATIONS

• COMPLICATIONS DUE TO ACCESS PLACEMENT PRACTICES
• COMPLICATIONS DUE TO COST
• COMPLICATIONS DUE TO MEDICAL PROBLEMS
• INTERVENTIONS TO IMPROVE OUTCOMES
VASCULAR ACCESS: STENOSIS AND THROMBOTIC COMPLICATIONS

• NONMATURATION
• STENOSIS
• THROMBOSIS
• ACCESS FAILURE
NONMATURATION OF THE ACCESS

• ASSOCIATED WITH AVF

• CAUSES
  – NARROW VEINS/DESTROYED VEINS
  – COLLATERAL VEINS
  – VENOUS STENOSIS
  – ARTERIAL INSUFFICIENCY

• MAY BE SALVAGED
  – 44-82% REPEATED PROCEDURES REQUIRED
  – 75% 1 YR PATENCY
PATIENTS ARE INFREQUENTLY INSTRUCTED TO PROTECT THE ARM FOR VASCULAR ACCESS

HELD, AJKD 1997, 30 (SUPPL. 1)

Were You Told To Avoid Blood Draws or IV Lines Pre-ESRD?

1,238 patients, USRDS Dialysis Morbidity and Mortality Study - Wave 2
STENOSIS AND THROMBOSIS

Ven. Anas: 60%
Intra-graft: 28%
Central: 5%
Arterial: 3%
Mixed: 36%


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Fig. 2.19. Three different ways of managing a stenosis of a primary AV fistula. Fig. 2.19a. Creating a new anastomosis.
ACCESS FAILURE

• FISTULA THROMBOSIS (LESS THAN 0.25 EPISODES/PATIENT-YEAR AT RISK)
• FISTULA PATENCY (GREATER THAN 3.0 YEARS)
• GRAFT THROMBOSIS (LESS THAN 0.5 EPISODES/PATIENT-YEAR AT RISK)
• GRAFT PATENCY (GREATER THAN 2.0 YEARS)
FISTULA AND GRAFT SURVIVAL IN INCIDENT PATIENTS STARTING HD WITH A PERMANENT VA

Adjusted for differences in age, gender, diabetes, and peripheral vascular disease; *note: in Japan, there were only a small number (n=88) of incident patients for analysis so confidence interval (C.I.) at one year is much larger than for other countries; in Japan, 1 year AV Fistula survival C.I.=0.60-0.87. DOPPS I

VASCULAR ACCESS OPTIONS: AVF VS AVG

Primary Patency

Patency (%)

Month

0 mo 6 mos 12 mos 18 mos 24 mos

AVF

AVG

DOQI's Patency rate goal (30d):
- Forearm straight AVG: 85%
- Forearm loop AVG: 90%
- Upper arm AVG: 95%

Schwab, KI, 55, 2078, May 1999
VASCULAR ACCESS OPTIONS: AVF VS AVG

Cumulative Patency*

Patency (%)

AVF

AVG

Month

0 mo 6 mos 12 mos 18 mos 24 mos

*Intervention rate: AVG > 3X AVF

Schwab, KI, 55, 2078, May 1999
VASCULAR ACCESS OPTIONS: AVF VS AVG

Cumulative Patency With Prospective Monitoring & Intervention*

*Intervention rate: AVG > 6X AVF

Schwab, KJ, 55, 2078, May 1999
VASCULAR ACCESS:
NONTROMBOTIC COMPLICATIONS

• INFECTION
• HEART FAILURE
• ISCHEMIA AND NERVE INJURY
• ANEURYSMS AND PSEUDOANEURYSMS
• VENOUS HYPERTENSION
• SEROMA
• ACCESS IN THE LOWER EXTREMITY
INFECTION

• RESPONSIBLE FOR LOSS OF 20% OF ACCESS
• STAPH sp
• CLOTTED ACCESS
  – 20 PATIENTS WITH FEVER/SEPSIS AND + INDIUM SCANS HAD INFECTED CLOTS
  – 13/15 PATIENTS WITHOUT SYMPTOMS AND + INDIUM SCANS HAD INFECTED CLOTS
• MUPIROCIN FOR PREVENTION IN CARRIERS WITH REPEATED INFECTIONS
• 3 WEEK TREATMENT IS MINIMUM
HEART FAILURE

• RISK OF HIGH OUTPUT FAILURE
  – EQUAL AVF AND PTFE ACCESS
  – LIKELY WHEN FLOW > 20% C.O.

• LVH MAY WORSEN

• BNP MAY BE USEFUL ADJUNCT TO DIAGNOSIS

• DIFFICULT TO FIX

• INDEX OF POOR LIFE EXPECTANCY
Fig. 2.21. This upper arm PAVF had an estimated 6 L/min blood flow before "banding."
ISCHEMIA

- STEAL SYNDROME
  - 1-20% INCIDENCE IN UE ACCESS
- PARESTHESIAS
- COOLNESS
- MUSCLE ATROPHY
- CLUMSINESS, LOSS OF MOTOR FUNCTION
- DISTAL NECROSIS
- THREAT OF LIMB LOSS
- REQUIRES IR OR SURGICAL INTERVENTION
ANEURYSMS AND PSEUDOANEURYSMS

Cause/sites
- Puncture site
- Accessory veins
- Valve

Indication for intervention:
- Skin overlying fistula is compromised
- Risk of rupture
- Available puncture sites limited
- When it involves the arterial anastomosis (DOQI)
VENOUS HYPERTENSION

- INCOMPETENT VALVES OR CENTRAL STENOSIS
- EDEMA AND ULCERATION
- PRIOR IPSILATERAL CENTRAL VENOUS CATHETER
- IR OR SURGICAL CORRECTION

Fig. 2.20. Venous hypertension from PAVF usually affects the thumb and causes pain.
MEDIAL NERVE INJURY AND SEROMA

• MEDIAN NERVE INJURY
  – CARPAL TUNNEL
  – ENTRAPMENT BY HEMATOMA
  – STEAL

• SEROMA
  – LONG TERM SWELLING OVER PTFE GRAFT DUE TO EXUDATION OF PLASMA PROTEINS
  – POSSIBLE SOURCE OF INFECTION
  – ? ASSOCIATED WITH TOO EARLY USE OF GRAFT
LOWER EXTREMITY ACCESS

• 62% PATENCY @ 1 YEAR
• 50% COMPLICATION RATE
  – 18% INFECTION
  – 15% ISCHEMIA
  – 6.5% ANEURYSM
  – 6.5% AMPUTATION
HEMODIALYSIS ACCESS COMPLICATIONS

- COMPLICATIONS DUE TO ACCESS PLACEMENT PRACTICES
- COMPLICATIONS DUE TO COST
- COMPLICATIONS DUE TO MEDICAL PROBLEMS
- INTERVENTIONS TO IMPROVE OUTCOMES
Vascular Access Initiative: Rationale

- Vascular access is one of the most critical issues in improving dialysis quality:
  - Recent trends:
    - ↓Access Patency, ↑Morbidity/ Mortality, ↑Costs
  - Attributable to:
    - ↓AVF, ↑AVG, ↑Catheters
  - Access type is a major determinant of patient outcomes as well as financial outcomes
  - Most VA-related morbidity & costs due to grafts & catheters
HOW TO INCREASE FISTULA USE

- MULTIDISCIPLINARY APPROACH TO ACCESS
- EARLY REFERRAL
- RESTRICTION OF ACCESS PROCEDURES TO INTERESTED AND EXPERIENCED SURGEONS
- ROUTINE PREOPERATIVE VASCULAR MAPPING
- EFFORTS TO SALVAGE IMMATURE FISTULAS
- ENHANCED TRAINING OF DIALYSIS STAFF
CONSEQUENCES OF LATE REFERRAL

- LATE REFERRAL DECREASES LIKELIHOOD OF PERMANENT ACCESS AT INITIATION OF DIALYSIS.
- LATE REFERRAL INCREASES DIALYSIS CATHETER USE.
- PATIENT LESS LIKELY TO HAVE FISTULA PLACED IF DIALYSIS INITIATED WITH A CATHETER.
- FISTULA SURVIVAL WORSE IF PT STARTS DIALYSIS WITH A CATHETER.
4. Surgeon Selection

Possible specific changes:

- Nephrologists refer to vascular access surgeons willing to meet specific standards and expectations
- Surgeons are evaluated on frequency, quality, and patency of access placements
ACCESS INITIATIVE
M Sekkarie, Clin Nephrol 61:2004

- **PRE-PERIOD: SURGEON DRIVEN**
- **PERIOD 1: SURGEON EDUCATION - CARROT**
  - NEPHROLGIST DRIVEN
  - DOQI GUIDELINES
  - LITERATURE PROVIDED
  - SURGICAL EXPERTS AVAILABLE FOR CONSULTS
- **PERIOD 2: “INSISTENCE PHASE” - STICK**
  - IGNORE LOCAL VENOUS MAPPING
  - REFER TO OTHER SURGEONS WITH SKILL
  - NEPHROLGISTS INSIST ON FISTULA CREATION
  - TRACK SURGICAL RESULTS/OUTCOME
<table>
<thead>
<tr>
<th></th>
<th>PRE PROJECT</th>
<th>PERIOD 1</th>
<th>PERIOD 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>FISTULAE</td>
<td>12 (15%)</td>
<td>23 (27%)</td>
<td>36 (49%)</td>
</tr>
<tr>
<td>GRAFTS</td>
<td>61 (76%)</td>
<td>56 (66%)</td>
<td>28 (38%)</td>
</tr>
<tr>
<td>CATHETERS (includes maturing AV accesses)</td>
<td>7 (9%)</td>
<td>6 (7%)</td>
<td>10 (13%)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>80 (100%)</td>
<td>85 (100%)</td>
<td>74 (100%)</td>
</tr>
</tbody>
</table>
5. Full Range of Appropriate Surgical Approaches

Possible specific changes:

- Surgeons utilize current techniques for AVF placement including vein transposition
- Surgeons ensure mapping is performed if suitable vein not identified on physical exam
- Surgeons work with nephrologists to plan and place secondary AVF in AV graft.
7. AVF Placement in Catheter Patients

Possible specific changes:

- Regardless of prior access (e.g. AV graft), nephrologists and surgeons evaluate all catheter patients as soon as possible for AVF
- Facility implements protocol to track patients for early removal of catheter
HIGHLIGHTS FROM THE DOQI:

- **GUIDELINE 10:** MONITORING AVG FOR STENOSIS
  - PHYSICAL EXAM (QWK?)
  - DYNAMIC VP(200) (QWK)
  - $>125\text{MMHG} \times 3 \text{ TIMES}$ (COBE & OTHERS)
  - $>150\text{MMHG} \times 3 \text{ TIMES}$ (GAMBRO AK 10)
  - STATIC VP(0) (Q2WK)
  - RECIRCULATION (LATE PREDICTOR)
  - UNEXPLAINED $\Delta \text{ IN KT/V}$
  - ACCESS BLOOD FLOW (QA)

- **GUIDELINE 11:** MONITORING AVF FOR STENOSIS
  - PHYSICAL EXAM
  - RECIRCULATION (+)
  - DOPPLER ULTRASOUND
  - ACCESS BLOOD FLOW
  - ARTERIAL PRESSURE (AP)
  - VP (LESS HELPFUL)
SURVEILLANCE: STATIC VENOUS PRESSURE (ACCESS ALERT)

\[ nVP0 = \frac{VP0}{MAP} \]

\[ nAP0 = \frac{AP0}{MAP} \]
SURVEILLANCE: COLOR FLOW DOPPLER U/S

- CORRELATION OF QA WITH U/S DILUTION TECHNIQUE:

\[ QA(\text{DILUTION}) = 246.14 + 0.81 \times QA \text{ (COLOR FLOW DOPPLER)} \]

Sands et al, ASAIO, 42(5):M899, 1996
SURVEILLANCE: U/S DILUTION TECHNIQUE (TRANSONIC)
SURVEILLANCE: U/S DILUTION TECHNIQUE (TRANSONIC)

- Recirculation and Access Flow Measurement:

- Recirculation Identified by Sensor in Standard Dialysis Lines
- Access Flow Measured with Dialysis Lines Reversed
ACCESS FAILURE: AN EMPHASIS ON STENOSIS AND THROMBOSIS

The Vanderbilt experience:

- Predictive measures of VA thrombosis:

<table>
<thead>
<tr>
<th></th>
<th>Thrombosis</th>
<th>No thrombosis</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (%) M/ F</td>
<td>36/ 64</td>
<td>43/ 56</td>
<td></td>
</tr>
<tr>
<td>Qa (dilution) ml/ mi</td>
<td>875+/ -426</td>
<td>1193+/ -677</td>
<td>0.001</td>
</tr>
<tr>
<td>Qa (doppler) ml/ mi</td>
<td>762+/ -420</td>
<td>1171+/ -657</td>
<td>0.001</td>
</tr>
<tr>
<td>VP(200) mmHg</td>
<td>98+/ -97</td>
<td>97+/ -25</td>
<td>NS</td>
</tr>
<tr>
<td>AP(200) mmHg (-)</td>
<td>39+/ -27</td>
<td>42+/ -21</td>
<td>NS</td>
</tr>
<tr>
<td>Recirculation %</td>
<td>4.9+/ -4.8</td>
<td>5.2+/ -4.1</td>
<td>NS</td>
</tr>
</tbody>
</table>

- Changes in Qa over time predicts VA thrombosis:

91 pts followed for 18 mos. Qa measured q6 mos.
Thrombosed accesses (34/95) had 22% and 41% ↓ in Qa in the 1st & 2nd periods respectively. (non-thrombosed had 4% & 15%↓)
RR (thrombosis) is 13.6 fold if Qa ↓ by >35% (p<0.01)
ACCESS FAILURE: AN EMPHASIS ON STENOSIS AND THROMBOSIS

The Vanderbilt experience (cont’d):

- Impact of Qa measurement and subsequent intervention on VA thrombosis:

**Chronic Hemodialysis Patients**
(n= 115)

- Access Flow Measurement
  (U/S Dilution Technique)

  **Grafts (AVG)**
  (n= 73)

  - Low Qb (< 800 ml/ min)
    (n= 24)
  
  - Normal Qb
    (n= 49)

  **Fistulas (AVF)**
  (n= 42)

  - Low Qb (< 500 ml/ min)
    (n= 5)

  **Intervention**

  - Severe Stenosis (> 50%)
    39/ 39

  - Normal Qb
    (n= 37)

  **Shuntogram**
  39

  - Severe Stenosis
    5/5

  **Angioplasty**
  17

  **Surgery**
  20

  **Deferred**
  2

  **Surgery**
  4

Samaha et al, NKF 1999
ACCESS FAILURE: AN EMPHASIS ON STENOSIS AND THROMBOSIS

Impact of intervention on AVG thrombosis rate

Samaha et al, NKF 1999
NVAIII Change Concepts

1. Routine CQI review of vascular access
2. Early referral to nephrologist
3. Early referral to surgeon for “AVF only”
4. Surgeon selection
5. Full range of appropriate surgical approaches
6. Secondary AVFs in AVG patients
7. AVF placement in catheter patients
8. Cannulation training
9. Monitoring and surveillance
10. Continuing education: staff and patient
11. Outcomes feedback
A RULE “WRITTEN IN STONE”

SAVE VEINS NAMED CEPHALIC AND BASILIC FOR ACCESS THEY ARE NOT THROMBOPHILIC INTO AN ABYSS OR VORTEX HURL ALL OF YOUR GORE-TEX AND LIFE WILL BE ALMOST IDYLLIC

WILLIAM J. STONE, MD
PROFESSOR OF MEDICINE
CHIEF, NEPHROLOGY SECTION, VAMC
VANDERBILT UNIVERSITY MEDICAL CENTER