Monitorizació

Monitoring (Surveillance) of Vascular Access

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Problems:

- Nearly 75% of HD patients are hospitalized for vascular access-related problem within 2 years.
- Vascular access complications account for ~30% of hospital admissions in chronic HD programs.
- Hospitalization costs for vascular access problems exceed $1.5 billion per year, ~10% of Medicare ESRD expenditures.


USRDS 2010
Two Steps of Hemodialysis Access Surveillance:

Step 1. Identify patients with hemodynamically significant stenosis through low flow or decreased flow

Step 2. Improve access flow by PTA or Surgery before thrombosis
Two Steps of Hemodialysis Access Surveillance:

**Step 1.** Identify patients with hemodynamically significant stenosis through low flow or decreased flow.
Choice of Tools for Vascular Access Surveillance (*DOQI and European Guidelines*)

1. Access Blood Flow
2. Static Venous Pressure
3. Dynamic Venous Pressure
4. Access Recirculation
What is normal? Access Flow in Native Fistulae vs. Fistula Age (RC – Radiocephalic; BC – Brachiocephalic)

What is normal: AVF Flow in RC vs. BC

<table>
<thead>
<tr>
<th>#</th>
<th>Study</th>
<th>Country</th>
<th>Lower arm, ml/min</th>
<th>Upper arm, ml/min</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Begin et al, 2002</td>
<td>Canada</td>
<td>878 ± 308</td>
<td>1,197 ± 644</td>
<td>p&lt;0.005</td>
</tr>
<tr>
<td>2</td>
<td>Dixon et al, 2002</td>
<td>USA</td>
<td>938</td>
<td>1,247</td>
<td>p&lt;0.01</td>
</tr>
<tr>
<td>3</td>
<td>Polkinghorne et al 2004</td>
<td>Australia</td>
<td>1,063</td>
<td>1,290</td>
<td>p&lt;0.04</td>
</tr>
<tr>
<td>4</td>
<td>Wijnen et al, 2005</td>
<td>Holland</td>
<td>878 ± 411</td>
<td>1,350 ± 560</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>5</td>
<td>Tessitore et al, 2003</td>
<td>Italy</td>
<td>1,024</td>
<td>1,496</td>
<td>p&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>Mean, ml/min</td>
<td></td>
<td>950 ml/min</td>
<td>1310 ml/min</td>
<td></td>
</tr>
</tbody>
</table>
“Hemodynamically significant stenosis is defined as a > 50% reduction of normal vessel diameter (graft or draining venous system) accompanied by a hemodynamic, functional, or clinical abnormality. . .”
Purpose of Flow Surveillance: to identify patients with hemodynamically significant stenosis

25% drop of flow

Flow less than 500 ml/min for native fistula

K/DOQI, Canadian, European, Guidelines
How to measure Access Flow?
Flow-based Vascular Access Management

During

- Surgical Creation of the access
- Hemodialysis Surveillance
- Angioplasty and/or Surgical Revision
Access Flow Measurement with Reversed HD Lines

Dilution Methods
Krivitski, Kidney Int. 1995

Ultrasound Dilution, Krivitski, ASAIO J, 1995

Thermodilution, Schneditz, JASN, 1996

Optical Density: Saline, German, JASN, 1996

Optical Density: UF, Leypoldt, JASN, 1996

Conductivity, Lindsay, AJKD, 1997

Dialysance Method, Gotch, JASN, 1998

BUN Dilution, Lindsay, ASAIO J, 1998

Ionic Dialysance, Mercadal, KI, 1999

BUN Dilution, Lindsay, ASAIO J, 1998

Ionic Dialysance, Mercadal, KI, 1999
Access Flow Measurement with Reversed HD Lines (commercially available)

Dilution Methods
Krivitski, Kidney Int. 1995

Ultrasound Dilution, Transonic Systems Inc. (stand alone)
Thermodilution, Fresenius (in HD machine)

Dialysance Method, Fresenius (in HD machine)
Access Flow Measurement with Reversed Line Position

Krivitski NM, Kidney Int. 48:244-250, 1995
Depner TA, Krivitski NM, ASAIO J 41:745-749, 1995
Nurse can do a measurement during HD simply, accurately within 5 minutes

More than 100 papers were presented since 1995 introduction of access flow reversed line technology

USA, Canadian and European access surveillance Guidelines based on these papers
Countries with largest to moderate flow surveillance programs

1. Surveillance programs 80-95% of HD population: Canada, France, Holland, Singapore
2. Surveillance programs 20-40% of HD population: USA, Australia, S. Korea, Japan
# Vascular Access Related Morbidity


<table>
<thead>
<tr>
<th>Event</th>
<th>Control (event per AVF year)</th>
<th>PTA (event per AVF year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospitalization</td>
<td>1.994</td>
<td>0.603</td>
</tr>
<tr>
<td>AVF failure</td>
<td>0.363</td>
<td>0.111</td>
</tr>
<tr>
<td>Thrombectomy</td>
<td>0.317</td>
<td>0.074</td>
</tr>
<tr>
<td>Elective surgical revision</td>
<td>0.046</td>
<td>0.037</td>
</tr>
<tr>
<td>Central catheter placement</td>
<td>0.25</td>
<td>0.049</td>
</tr>
</tbody>
</table>
Failed randomized trails


Two Steps of Hemodialysis Access Surveillance:

**Step 2.** Improve access flow by PTA or Surgery before thrombosis
Expected Vascular Access Survival Time after Successful PTA (Guidelines)

Grafts: more than 6 month

Native Fistula: more than a year
Major Clinical and Financial Problem

In more than 150,000 angioplasties/year of A-V accesses in the US alone:

- More than 20% of angioplasty procedures in A-V grafts are not immediately successful
- In nearly 50% shunt flow returns to pre-angioplasty level within 3 months

In all cases, PTA was reported to be successful i.e. residual luminal reduction of <25%” p.718
Whose Story is Right?  
Different judgment

Interventional radiologist:  
Success > 85 – 100%
Stenosis reduction vs Flow increase

Nephrologists:  
Success < 50%
Nephrologists’ Side

Methods: Transonic HD01,02 Monitors
Access Flow before PTA during hemodialysis (last session)  

Δ Flow increase  ?  

PTA  

Access Flow after PTA during hemodialysis (session 1-2 weeks after)
Average Access Flow Increase ($\Delta Q$) in HD unit after PTA. Weighted average $\Delta Q = 283$ ml/min, $n=747$. 

21 studies
Why This Failed?


Because:

Blood flow increase after PTA for more then 20% (near 120 ml/min) of initial flow occurred in 41% of the grafts.
Radiologist’s Side
Stenosis Reduction <30% of the Main Lumen Diameter

a) Is blood flow adequately increased?
b) Will it last 10 minutes?
What is the Goal?

Flow after intervention:

AVG > 1000 ml/min;

AVF > 800 - 900 ml/min;
Summary: Interventional radiologists should use some additional objective means to improve outcomes.
Endovascular Thermodilution Flowmeter

Flow Measurement During Angioplasty HVT100
Antegrade and Retrograde 6F Catheters

Diagram showing the flow measurement setup during angioplasty. The diagrams illustrate the flow paths for antegrade and retrograde injections, with labels for Dilution Thermistor, Injected Saline, Graft Flow, Introducer (Sheath), Antegrade Catheter, Retrograde Catheter, and Injection Thermistor.
How blood flow during PTA can help?

1. Identify recoil process.
2. Make decision about necessity for PTA
3. Decide on continuation of treatment of possibly hemodynamiclly significant stenosis or finish intervention procedure
Recoiling of Stenosis Lesion

*(catheter access flow measurement in angio-suit)*

Krivitski NM: Semin Dial 16:304—308; 2003
Catheter Based Flow Measurements during Angioplasty (Scott Trerotola group)

- 1,540 total interventions
- 104 qualifying flow measurements (6.7%)
  - Fistulae (n=70) and grafts (n=34)
  - Led to decision to treat in 14
  - Led to decision NOT to treat in 36

Leontiev et al, JVIR 2013;24:717-721

*J Vasc Interv Radiol, 2006*
Can blood flow surveillance and pre-emptive repair of subclinical stenosis prolong the useful life of arteriovenous fistulae?
A randomized controlled study

Nicola Tessitore¹, Giovanni Lipari², Albino Poli³, Valeria Bedogna¹, Elda Baggio², Carmelo Loschiavo¹, Giancarlo Mansueto⁴ and Antonio Lupo¹
Native Fistulae Survival

![Graph showing survival rates over follow-up months for Treatment and Control groups. The graph illustrates a comparison of survival rates with a p-value of 0.050. The table below the graph shows the number of AVFs at risk for each group at different follow-up periods.]

<table>
<thead>
<tr>
<th>Follow-up (months)</th>
<th>Treatment</th>
<th>Control</th>
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<tbody>
<tr>
<td>0</td>
<td>43</td>
<td>36</td>
</tr>
<tr>
<td>12</td>
<td>35</td>
<td>31</td>
</tr>
<tr>
<td>24</td>
<td>25</td>
<td>24</td>
</tr>
<tr>
<td>36</td>
<td>20</td>
<td>13</td>
</tr>
<tr>
<td>48</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>60</td>
<td>12</td>
<td>3</td>
</tr>
</tbody>
</table>
Thank you!
Vascular Access Flow Program - Team Effort

- Intraoperative Flow Measurement
- Access Flow Monitoring
- Angioplasty or Surgery
- Post Intervention Flow Measurement
Access Flow Measurement with Reversed HD Lines

Dilution Methods
Krivitski, Kidney Int. 1995

- Ultrasound Dilution, Krivitski, ASAIO J, 1995
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- Dialysance Method, Gotch, JASN, 1998
- BUN Dilution, Lindsay, ASAIO J, 1998
- Ionic Dialysance, Mercadal, KI, 1999
Prediction of Early Access Failure by Intraoperative Flow Measurements

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<tr>
<th>Access Type</th>
<th>Failure within 90 days (requiring intervention)</th>
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<tr>
<td><strong>Radiocephalic</strong></td>
<td></td>
<td></td>
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<tr>
<td>Flow ≤ 170 ml/min</td>
<td>9/16 (56%)</td>
<td></td>
</tr>
<tr>
<td>Flow &gt; 170 ml/min</td>
<td>12/81 (15%)</td>
<td>P = .001</td>
</tr>
<tr>
<td><strong>Brachiocephalic</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow ≤ 280 ml/min</td>
<td>9/14 (64%)</td>
<td></td>
</tr>
<tr>
<td>Flow &gt; 280 ml/min</td>
<td>21/115 (18%)</td>
<td>P = 0.01</td>
</tr>
<tr>
<td><strong>PTFE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow ≤ 400 ml/min</td>
<td>28/44 (65%)</td>
<td></td>
</tr>
<tr>
<td>Flow &gt; 400 ml/min</td>
<td>47/118 (40%)</td>
<td>P = 0.01</td>
</tr>
</tbody>
</table>