

# VASCULAR ACCESS MONITORING: CAN WE DO IT BETTER?


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 New York, NY  
 Session: Important Issues in Hemodialysis Access  
 Nov 23, 2024

Nothing to Disclose for this Presentation

## Objectives

- Define vascular access monitoring (vs. surveillance)
- Share what Guidelines say
- Evidence to support monitoring
- Can we do it better?
  - And how can we do it better





## Clinical Monitoring vs. Surveillance

**Clinical monitoring:** Monitoring refers to the examination and evaluation of the access by means of physical examination or check to detect clinical signs that suggest the presence of AV access flow dysfunction, other dysfunction, or pathology. These abnormal clinical signs may include arm swelling, changes in the access bruit or thrill, or prolonged bleeding after dialysis (Tables 13.1 and 13.2). The patient's physical examination can be supplemented with concurrent dialysis measures such as those indicating recirculation (when needle placement is correctly spaced and placed) or other measures of reduced dialysis adequacy (eg, urea reduction ratio or Kt/V), in the absence of other contributing factors.

**Surveillance:** The periodic evaluation of the vascular access by using device-based methods or tests that involve special instrumentation, beyond clinical examination and for which an abnormal test result suggests the presence of thrombotic flow-related complications/dysfunction

*KDOQI Vascular Access Guidelines 2019, Glossary*

## Clinical Monitoring vs. Surveillance (simplified)

<p><b>PHYSICAL EXAM or CHECK</b></p> <p>+/-</p> <p>Data from dialysis (nothing extra)</p> 	<p><b>SPECIAL EQUIPMENT</b></p> <p>Needs extra training to use or interpret</p> 
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## KDOQI on Monitoring & Surveillance

13.1 KDOQI recommends regular physical examination or check of the AVF, by a knowledgeable and experienced health practitioner, to detect clinical indicators of flow dysfunction of the AVF. (Conditional/Strong Recommendation, Moderate Quality of Evidence)  
 See Table 13.2 for clinical indicators

13.4 There is inadequate evidence for KDOQI to make a recommendation on routine AVF surveillance by measuring access blood flow, pressure monitoring, or imaging for stenosis, that is additional to routine clinical monitoring to improve access patency.

Note: In other words, monitoring of vascular access is primary, while surveillance findings are supplementary, and action should not be based solely on surveillance findings.

### What's the evidence for monitoring?

Comparative Study | Am J Kidney Dis. 1991;17(3):303-6.  
doi: 10.1016/j.ajkd.1991.03.003

#### Use of the fistula assessment monitor to detect stenoses in access fistulae

J S Gani<sup>1</sup>, P R Fowler, A W Steinberg, J H Wlodarczyk, R S Namra, A D Hibberd

Fistula assessment monitoring was more accurate (96%) than combined clinical assessment (accuracy, 52%) in stenosis detection. Complications of angiography occurred in 17%.

Fistula assessment monitoring was better than combined clinical assessment in predicting clinical outcome for arteriovenous fistulae over 6 months and was as good as angiography. Routine fistula assessment monitoring could reduce inappropriate angiography and detect clinically significant silent stenoses. It is an ideal method for monitoring arteriovenous access fistulae.

### What's the evidence for monitoring?

J Vasc Interv Radiol. 1996 Jun;7(1):15-20. doi: 10.1016/s1051-0443(96)70726-1

#### Screening for dialysis access graft malfunction: comparison of physical examination with US

S O Theriot<sup>1</sup>, P J Scheel Jr, N R Powe, C Prescott, N Feeley, J He, A Watson

**Conclusion:** Physical examination is a good screening test for ruling out the low flows associated with impending access graft failure, thereby eliminating the need for routine US for many patients.

Am J Kidney Dis. 2001 Oct;38(4):853-7. doi: 10.1053/ajkd.2001.27706.

#### Buzz in the axilla: a new physical sign in hemodialysis forearm graft evaluation


R Agarwal<sup>1</sup>, G McDougal

This single physical sign also correlated with subsequent graft failure and should be incorporated into physical examinations of all dialysis grafts.

### So, what do we mean by "Exam or Check"?

**STOP**

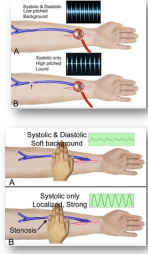
Before beginning dialysis, stop to LOOK, LISTEN, AND FEEL



Signs of a healthy fistula	LOOK	LISTEN	FEEL
<ul style="list-style-type: none"> <li>No swelling</li> <li>No areas that balloon out</li> <li>No redness</li> <li>No open sores</li> <li>No leaks</li> <li>No drainage</li> <li>No bruising</li> </ul>	<ul style="list-style-type: none"> <li>Swelling</li> <li>Areas that balloon out</li> <li>Redness</li> <li>Open sores</li> <li>Leaks</li> <li>Drainage</li> <li>Bruising</li> </ul>	<ul style="list-style-type: none"> <li>Bruit is a continuous, low pitch and sounds like the ocean</li> </ul>	<ul style="list-style-type: none"> <li>Bruit is high pitched and sounds like a whistle or a whirr</li> <li>There is a weak pulse felt 6 in. above start of fistula</li> <li>Temperature of access arm and/or hand is warm to touch</li> <li>Temperature is different between hands and arms</li> </ul>

Figure 1. A. New fistulae feel "loose" to the arm. B. Stenosis. The fistula is described as "tight." C. When the arm is irrigated, the fistula is described as "off." D. When the arm is irrigated, the fistula is described as "off."

### Who does this and how good is it?



Semin Dial. 2015 Sep-Oct;28(5):544-7. doi: 10.1111/sdi.12381. Epub 2015 Mar 20.

#### Prediction of Arteriovenous Fistula Dysfunction: Can it be Taught?

Joel E Rosenberg<sup>1</sup>, Alexander S Yevlin<sup>1</sup>, Mosh R Chan<sup>1</sup>, Amanda M Valliani<sup>1</sup>, Brad C Azor<sup>1</sup>

Physical exam findings were categorized blindly by each examiner into four categories of lesion location: inflow, outflow, both, or neither. Data were privately recorded and compared to the gold standard of angiographic results.

The full-time interventional specialist demonstrated correct prediction of lesion location of 89.0% (kappa = 0.850), while the undergraduate student had a correct prediction of 77.0% (kappa = 0.823). The student's performance, however, differed significantly over time. The student correctly predicted the location of the lesion in 6 (42.9%) of the first 14 patients (kappa = 0.062), compared to 3 (42.9%) of the last 35 patients (kappa = 0.855).

**At end, Undergraduate student had 81.4% accuracy, Interventionalist = 54.3%, Kappa=0.83**

### How do assessors compare with each other?

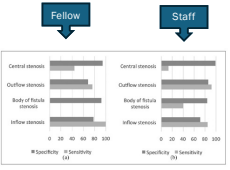
Comparison Study | Semin Dial. 2008 Nov-Dec;21(6):507-60.  
doi: 10.1111/j.1525-1302.2008.01571.x

Physical examination of arteriovenous fistulae by a renal fellow; does it compare favorably to an experienced interventionalist?

Carlos Leon<sup>1</sup>, Jeff Hill

% Agreement (compared with GS=Angiography)

Lesion	Fellow	Staff (IN)
Outflow	81%	89%
Inflow	80%	83%
CVS	79%	11%




An NF can be trained in physical examination and accurately detect and localize stenoses in a great majority of arteriovenous fistulae when compared with an IN. We suggest that nephrology training programs should place more emphasis on this aspect of vascular access education.

Does this happen?

### What does KDOQI say?

13.3 KDOQI considers it reasonable for nephrology trainees and health practitioners involved with clinical HD patient care to be properly trained in physical examination of the AV access to monitor for and detect AV access flow dysfunction. (Expert Opinion)

What do you call a beginner runner who's struggling with hills? An uphill battle!



### Reality

> J Nephrol. 2024 Jul 30. doi: 10.1007/s40620-024-02013-7. Online ahead of print.

**Insights into the real-world practice of vascular access care pathways in Italy: data from a national survey**

Laura Buzzzi <sup>1</sup>, Ivano Baragetti <sup>2</sup>, Michela Maria Barbagallo <sup>2</sup>, Antonio Marciello <sup>3</sup>, Massimo Lodi <sup>4</sup>, Walter Morale <sup>5</sup>, Marcello Napoli <sup>6</sup>, Giacomo Forneris <sup>7</sup>

First-level monitoring (physical examination) was primarily done by nurses in two-thirds of facilities.

N=124 dialysis facilities; 12,276 patients

### How can we do better?

- #1 Basics = EDUCATE, TRAIN and TRAIN! Re-educate and refresh
- Augment and objectify - LOOK, Listen, Feel

> NPJ Digit Med. 2023 Sep 1;6(1):163. doi: 10.1038/s41746-023-0139-5.

Deen T...

> Cardiovasc Eng Technol. 2015 Dec;6(4):463-73. doi: 10.1007/s12239-015-0239-5. Epub 2015 Aug 4.

**Dysfunction Screening in Experimental Arteriovenous Grafts for Hemodialysis Using Fractional-Order Extractor and Color Relation Analysis**

Ming-Jui Wu <sup>1</sup>, Wei-Ling Chen <sup>2</sup>, Chung-Dam Kan <sup>3</sup>, Fan-Ming Tu <sup>4</sup>, Su-Chin Wang <sup>5</sup>, Hsiu-Hui Lin <sup>6</sup>, Chia-Hung Lin <sup>7</sup>

We found the best model can screen for stenosis at a what of a nephrologist performing a physical exam, but with the automated and scalable

### How can we do better?

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> J Vasc Access. 2022 May;23(3):390-397. doi: 10.1177/1129729821993984. Epub 2021 Feb 14.

**Vascular sound visualization system is useful for monitoring and surveillance of vascular access**

Masato Tsuboi <sup>1</sup>, Hiroaki Suzuki <sup>1</sup>, Hirokazu Kawai <sup>1</sup>, Toru Ejima <sup>1</sup>, Fukumi Mitsuishi <sup>1</sup>

> Ann Biomed Eng. 2002 Jul-Aug;30(7):882-886. doi: 10.1002/abeb.10023. Epub 2002 Jul 12.

**Monitoring hemodialysis vascular access with a phonoangiogram**

John Doyle <sup>1</sup>, Daniel...

> Med Biol Eng Comput. 2005 Jan;43(1):56-62. doi: 10.1007/s11517-004-0023-4.

**Computerised analysis of auscultatory sounds related with vascular patency of haemodialysis**

> IEEE Trans Biomed Circuits Syst. 2019 Dec;13(6):1494-1505. doi: 10.1109/TBCAS.2019.2948303. Epub 2019 Oct 18.

**Flexible, Skin Coupled Microphone Array for Point of Care Vascular Access Monitoring**

Bilal Panda, Sourav Mondal, Steve J A Mearns

### How can we do better?

- #1 Basics = EDUCATE, TRAIN and TRAIN! Re-educate and refresh
- Augment and objectify - Look, Listen, FEEL

> Annu Int Conf IEEE Eng Med Biol Soc. 2021 Nov;2021:7324-7327. doi: 10.1109/EMBC46164.2021.9830463.

**Measurement of Tremor on Arteriovenous Fistulas with a Flexible Capacitive Sensor**

Kan Luo, Cong Cai, Zhichen Lai, Bingfa Huang, Jiansheng Cai, Chaobing Liang, Jianxing Li

### How can we do better?

- #1 Basics = EDUCATE, TRAIN and TRAIN! Re-educate and refresh
- Augment and objectify - LOOK, LISTEN, FEEL - all together?

**PaltenSee**

CONTACTLESS IMAGING SYSTEM FOR RAPID VASCULAR ACCESS MONITORING

### Summary

- Monitoring can have excellent accuracy ( in detecting problematic AV access
- Education and training can make significant improvements in accuracy in a short time
- Reality = lack of training and experience in dialysis workforce
- New monitoring technology to "Look, Listen, Feel" may augment clinical skills

Thank you for your attention