


Ultrasound Assisted Cannulation For Hemodialysis Access – A Paradigm Shift

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Disclosures

- **Employer:**
 - Emory University
- **Advisory/Leadership Role:**
 - ASDIN Immediate Past-President, 2024-2026
 - Kidney Health Initiative Board of Directors, 2022-2023, 2024-2025
 - Transforming Dialysis Access Together (ASN/CDC), 2023, 2024
 - Editorial Board Member for ClinicalKey, 2022-2025
 - Site PI: Two Plus Incremental HD Study (PCORI)
- **Consultant:**
 - BD ESKD Futures Forum, 2023
 - HPME Educational, 2023
 - Sonavex, 2024
 - Vexev, 2024

Emory Dialysis Quality Improvement Initiative

Goal:


- To empower dialysis staff with the skills needed to use US
 - To assess AV fistulae for maturity
 - To guide cannulation.
- 4 outpatient units at Emory Dialysis
- 750 patients
- Barriers to ultrasound use:
 - **Lack of portable US**
 - Portable ultrasound devices and iPADS at each unit
 - **Training**
 - Simulation workshop



Niyyar VD. Ultrasound-based Simulation for Cannulation in Outpatient Hemodialysis Units: An Educational Protocol. JVA Nov 2019

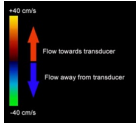
Emory Dialysis Quality Improvement Initiative

- Combination of **didactic** and **hands-on** components
- 18 participants
- **5 stations**
 - Didactic lecture on fundamentals of ultrasound
 - Familiarity with device
 - Identification of vasculature
 - Cannulation simulation using models
 - Assessing maturity for cannulation
- Pre- and post- evaluation surveys




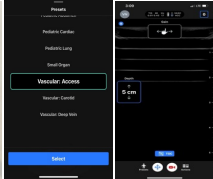
Station 1: Didactic lecture on fundamentals of US

- **B-Mode:**
 - Sound wave travels through tissue and reflected back towards transducer
 - Velocity of sound independent of tissue type – can be converted to anatomic depth
 - 2-dimensional image produced based on time interval and intensity of sound
- **Color Doppler**
 - Color superimposed on B-Mode image
 - Degree of color saturation – Flow velocity
 - Hue – Direction of flow
 - BART: Blue Away, Red Towards
- Quantitative measurements **not** discussed



Station 2: Familiarity with device

- Selecting the right pre-set (vascular access)
- Adjusting the gain and depth of the image
- Freezing the image
- Taking measurements
- Annotation
- Saving images
- Uploading images
- Sharing de-identified images

Station 3: Identification of vasculature

- Focused on identifying vascular anatomy correctly
- Differentiate arteries from veins
 - Pulsatility
 - Compressibility
- Performed US on each other
- US on simulation models
 - Visualize “vessel” in transverse and longitudinal views



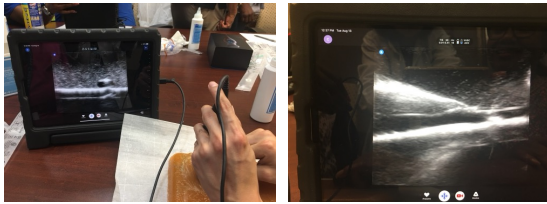
Station 4: Cannulation Simulation Using Models

- Simulation models
 - Gelatin
 - Metamucil
 - Penrose drains
- Identify tip of needle in both longitudinal and transverse views
- Real-time guidance for cannulation
- Visual maps



Emme S. Home-made Ultrasound IV Model. https://www.youtube.com/watch?time_continue=1&v=yov8t7ZDNG

Station 4: Cannulation Simulation Using Models



Station 5: Assessing Maturity for Cannulation

- Discussion of “Rule of 6”
 - 6 mm diameter
 - 6 mm depth
 - 6 cm straight segment
- No flow measurements
- Emphasis on
 - Physical examination
 - Clinical experience
 in assessing access maturity



Robbin ML, Chamberlain NE, Lockhart ME, et al. Hemodialysis arteriovenous fistula maturity: US evaluation. *Radiology*. 2002;225(1):59-64.

Effectiveness of ultrasound-guided cannulation of AVF on infiltration rates: QJ Emory Dialysis

- 6-month study period
 - All NEW fistulae created during the study period
 - ALL NEW fistulae accessed for the first time during the study period (irrespective of creation date)
- Physical examination along with ultrasound assessments performed at regular intervals
 - 0-2 weeks post-surgery
 - 4-6 weeks post-surgery
 - At the time of first 1 needle cannulation
 - At the time of first 2 needle cannulation

Niyyar et al. Effectiveness of ultrasound-guided cannulation of AVF on infiltration rates: A single center QJ study. *JVA* 2021

Ultrasound Assessments

- To minimize inter-observer and intra-observer variability, depth and diameter measurements were measured at the following specified distances from the arterial anastomosis
 - 2 cm
 - 4 cm
 - 6 cm
- Emphasis on minimal probe pressure so as not to compress the AVF – aim for “circle”
- At 4-6 weeks, AVF assessed for maturity
 - Immature – referred for intervention
 - Mature – Plan for cannulation



Ultrasound Assessments

- Ultrasound guidance used to mark and cannulate ALL new AVF
- Ultrasound performed at
 - First cannulation with one needle
 - First cannulation with two needles
- Ultrasound marking for cannulation
 - Visual map to guide cannulation
 - Real-time guidance
- Weekly team meetings to discuss progress and trouble-shoot

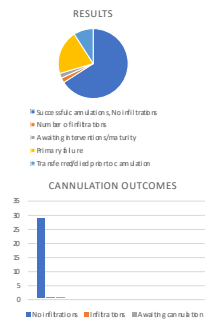


Physical Examination and Ultrasound Assessments

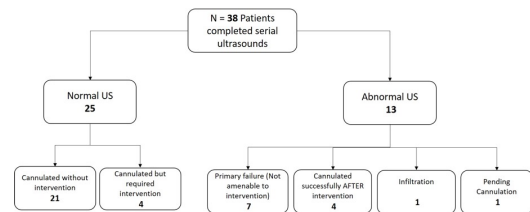


Results

- AVF created in **39 patients** during the study period
- AVF placed prior to 6/2020 in **5 patients** but accessed for the first time within the study period also included
- Total n = **44 patients**
 - 2 died
 - 2 transferred out before cannulation
- **40 patients** in the final analysis
 - 9 with primary failure, confirmed with US measurements
 - 31 patients progressed in the study
 - 29 successfully cannulated with 2 needles
 - 1 infiltration in a femoral AVF (patient moved *after* cannulation and dislodged needle)
 - 1 patient still not cannulated

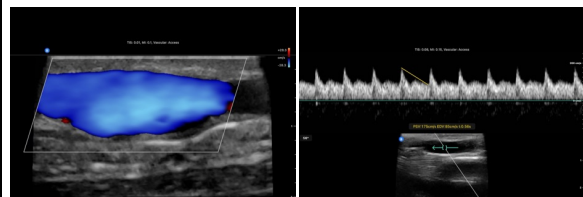


Results: How successfully did our US findings predict the outcome?

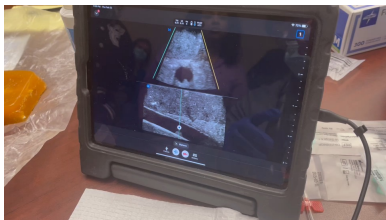


What next?

Color Doppler and PSV Assessment

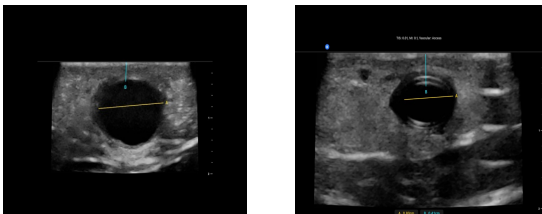


Biplane Imaging For Real-time Ultrasound Cannulation



**Expanding US use at the bedside:
A case-based approach**

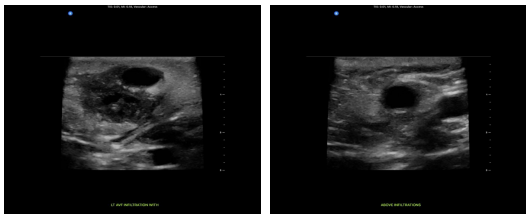
Case # 1



Case # 2



Case # 3



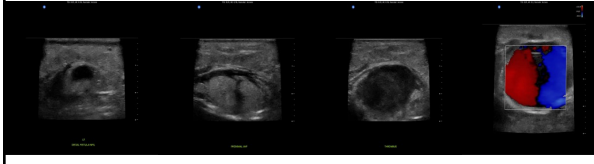
Case # 4

- Difficult cannulation
- Procedure at outlying facility



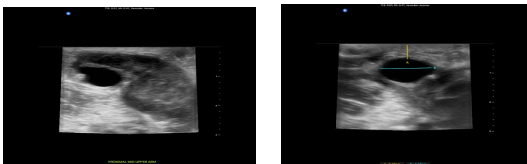
Case # 5

- Pain and swelling 3 days post-op



Case # 6

- Liver transplant recipient, immunosuppression
- No constitutional symptoms




Combining Innovative Technologies: Point-of-care Ultrasound + Telemedicine

- **Goal:** Incorporate Point-of-care ultrasound in the dialysis unit during telemedicine visits to evaluate AVF
- **Patient Population:** Hemodialysis patients at Emory Dialysis with AVF placement > 6 weeks
- **Interventions: Simultaneous assessments**
 - Dialysis unit: Vascular access coordinator performed physical exam and US of AVF for depth, diameter and course of the AVF
 - Office: Telemedicine visit by vascular surgeon
- **Results:** Pilot study of 5 patients
 - 3 patients - Mature accesses, Ready for cannulation
 - 1 patient - Inflow stenosis diagnosed, cannulated successfully after angioplasty
 - 1 patient - AVF too deep, scheduled for superficialization within a week of the visit
- **Conclusions:** Telemedicine examination of the ESKD patient in the dialysis unit assisted by point-of-care ultrasound may be a superior way to assess problematic access and promptly develop a treatment plan as it is a means of direct communication between the dialysis staff and the vascular surgeon.

Point-of-Care Ultrasound Enhances Dialysis Access Evaluation During Telemedicine Visits In Outpatient HD Units.
G. Shadrilova, M. Chang, V. Nivner, V. Teodorescu. Journal of Vascular Surgery, 2020

Summary

- Workshop provides exposure to US equipment and hands-on practice **but does not make a novice an expert**
 - Regular practice, evaluate competencies periodically
- US **complements** physical examination – adjunct, not replacement
- Adding point-of-care ultrasound provides a unique dimension to the management of hemodialysis vascular access and **optimizes** dialysis access care



THANK YOU!

- **Emory Dialysis and Health Systems Management**
 - Funding the purchase of the ultrasounds and iPads
 - Adjusting clinical schedules to allow interested staff to participate
- **Vascular Access Coordinators**
 - Forest Rawls and Rodella Broxton
- **Nephrology Fellows**
 - Sunitha Kalyanam, Niraj Karki, Kunal Buch
- **Cannulation models**
 - Siegfried Emme, MSN, NP-C, CEN, CCRN
 - Prashant Dheerendra, MD