Reviewing Approaches to Blood Draws

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Introduction & Disclosures

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* Employee, shareholder and board member of Velano Vascular, Inc.

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Tonight’s Agenda

1. Suboptimal Blood Collection Practices

2. Hurdles of PIV Blood Aspiration

3. Vascular Anatomy and the Role in Access
A Ubiquitous Yet Suboptimal Procedure

~450M
CONDUCTED EVERY YEAR
IN U.S. HOSPITALS (INPATIENT)

1.6 – 2.2X
Average daily draws

28% Adults, 43% Peds
> 1 stick attempt

88% Nurses
Say sticks / re-sticks impact
patient experience

15-25%
3+ Draws Daily

* Internal Data on File
Venous Depletion: Setting the Stage

- **Definition Attempt**: Loss of suitable veins for cannulation, IV therapy or dialysis due to damage from existing or past VADs or venipuncture

- Venous depletion, vein wasting and vein preservation are concepts gaining attention as a means to increase appropriate use of peripheral veins and reduce the need for central vascular access devices (CVADs)
  - Lynn Hadaway. Infusion Teams in Acute Care Hospitals. JIN. 2013

- Last few decades frequency & intensity of venous cannulations & venipunctures for hospitalized patients increased dramatically

<table>
<thead>
<tr>
<th>Category</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIV</td>
<td>310,000,000</td>
</tr>
<tr>
<td>CVC</td>
<td>5,000,000</td>
</tr>
<tr>
<td>PICC</td>
<td>2,000,000</td>
</tr>
<tr>
<td>Midline</td>
<td>~400,000</td>
</tr>
<tr>
<td>Venipuncture (Inpatient)</td>
<td>~400,000,000</td>
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Pervasive Cannulations of Vessels

Vascular Access Devices (VADs) are Ubiquitous
- ~95% of hospitalized patients have at least 1 vascular access device
  - 80% had PIVs - 73% had 1 PIV, 7% had 2 PIVs simultaneously
  - 15% had central access (PICCs, CVC, Ports)
    - 20% of Patients w/ CVC, PICCs had at least 1 PIV

Vessel Cannulation often requires multiple attempts
- PIV starts have ~28% multiple attempts incidence
- 1st venipuncture attempt success rates:
  - 74%-88% in adults, 46%-76% in pediatrics
  - 25% experience fishing/probing

Frequency of vessel accessing higher than ever
- 1.6x - 2.2x avg. blood draws per hospital day
- 15% - 25% patients w 3+ avg blood draws per day
- 1 out of 6 pts experience 10-20 blood collections during stay
- 20% of patients had at least 2 admissions in given year (frequent fliers)

~12-14 average vessel cannulations per patient admission

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On average what percent of Central Line accesses are **ONLY** for blood collection?
Risks & Over Utilization of Central Access?

- **CVCs / PICCs carry significant patient risk**
  - Infection (CLABSI) – 1.67 per 1000 CL days
  - Thrombosis - 10% symptomatic, 38% seen in PICCs

- **Mounting evidence of inappropriate escalation to PICCs or extended CVC dwell days** (Chopra 2015)
  - 43% of PICC insertions rated as inappropriate
  - **Inappropriate Indication for PICC Use:**
    - “Patient or family request in a patient who is not actively dying or in hospice, for comfort in obtaining *daily blood samples* for laboratory analysis”
  - Table 3: Thematic Concerns Raised by Panelists:
    - “PICCs ordered or maintained for blood draws—is this appropriate?”
On average what percent of Central Line accesses were **ONLY** for blood collection?

**Answer?**
Over Utilization of Central Access for Blood Draws?

Reducing Risks of Central Line Access and Viability of Moving to The Periphery
Cheryl O’Malley, DNP, VP Patient Care Services & Nursing, University Hospitals Cleveland Medical Center, 2017 IHI Conference Poster

- Over 22% of all accesses of a line are due to blood collections
- Lines accessed 7-11 times per 12 hour shift
- CICU was more likely to use line for blood collection (>42%)
- Banning Central Line blood draws in ICUs starting to occur with associated CLABSI reduction reported
Hershey Study: “Limiting Access Limits Infection”

- **SETTING:**
  - Academic center - 49 bed med/surg unit with 230 central line patient days / month

- **METHODS:**
  - Interprofessional team of nurses, physicians, phlebotomists, infection prevention experts created “No Central Blood Draw” Program
  - Avoided central access for blood draws, instead increased use of venipuncture and capillary sticks
  - Allowed up to 4 venipuncture attempts unless DVA or patient refusal, then physician order required

- **RESULTS:**
  - Reduced avg. accesses of central lines from 6 to 1.4x daily (77%)
  - Dropped CLABSI rate from 2.99 per 1,000 line days to ZERO
  - Reduced mislabeled or contaminated specimens sent to lab
Why is everyone ignoring the PIV?

Potential Concerns

- Hemolyzed specimen?
  - Improve patient experience (avoid venipunctures)
  - Avoid bruising, pain, multiple sticks / fishing
  - Improved sleep
  - Less agitation/escalation for delirious & demented patients

Potential Advantages / Benefits

- Diluted / contaminated specimen?
  - Preserve vasculature, esp. DVA, CKD, Onc & frequent fliers

- "Blow" IV line or vein?
  - Reduce reliance on central access

- Phlebitis risk?
  - Reduce accidental needle sticks

- Workload / workflow shifts?
  - Provider satisfaction

- Improve workflow, time to result, efficiency and cost
Hurdles of PIV Blood Aspiration

New Insights from Clinical Research
Why is everyone ignoring the PIV?

- **INS 2016 Standard Change:**
  - “Obtaining blood samples from indwelling PIVs for Peds, DVAs, bleeding disorders, need for serial tests”

- **However, reality is that PIVs after initial insertion become unreliable for aspiration**
  - Recent Pediatric IV blood sampling study reported success rate for PIVs > 24 hrs indwelling only at 63%\(^1\)
    - Despite reliability shortcoming, patient-centered goodwill generated:
      - RNs reported “pride” in saving their patients a painful procedure
      - Even if failed draw, families reported “appreciation” for attempt
      - Time savings of 30-45min per draw for Child Life
PIV in Peripheral Vein

Open Valve

Branch

Blood flow
Hurdles When Aspirating Blood Through a PIV

Successful blood aspiration from PIV requires one or both:
1. Adequate flow around PIV from behind
2. Access to reservoir/branches in front

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Effect of Venous Anatomy on PIV Success

PIV placed in deeper vein

Network of collateral branches

Venous Valve

PIV
Effect of Venous Anatomy on PIV Success

Kinked PIV in AC
Effect of Venous Anatomy on PIV Success

- Analysis of available venogram images showed higher count of branches and valves to cadaver study
- Demonstrated significant tortuosity of veins
- Limitation: Diabetic patient population with venous depletion
Summary: Hurdles for PIV Blood Aspiration

- **Repeated traumatic VAD insertions and venipunctures**
  - Wall damage & scarring
  - Valve damage leading to incompetence
  - Bruising / hematomas makes site unusable for subsequent sticks (other sites often “harder”)

- **VAD catheter direct mechanical irritation**
  - Placement in areas of flexion
  - Subpar securement and stabilization (ie. “pistoning”)

- **Obstruction / Reduction of blood flow**
  - If catheter occupies 50% of vessel diameter = 90% reduction in flow
  - Securement on skin can put pressure above vessel reducing flow
  - Clotting & fibrin tails form due to slow flow + wall injury (Virchow’s Triad)

- **“No Flow Compartment” amplifies negative spiral**
  - Increases concentration of caustic infusates & contact time with endothelium
  - Collapses the vessel lumen which increases catheter mechanical irritation
4 “First of their Kind” Ultrasound Studies

Main Goals:
- Describe venous anatomy from hand to AC in a typical patient
- Quantify frequency of branches and valves
- Describe relationship of venous anatomy to PIVs
- Utilize best in class high frequency (13-18 mHz) probes
- Quantify “restricted flow” zone around PIVs

• Dr. Paul Gagne – Vascular Surgeon and Researcher, Vascular Experts (CT)
• Dr. Karun Sharma – Pediatric Interventional Radiologist, Children’s National Medical Center (DC)
• Dr. Matt Fields – Thomas Jefferson University Hospital, Emergency Ultrasound Group (PA)

*Studies supported by funding from Velano Vascular, Inc.*
Valve Findings

- The hand had the most valves within 10cm of mark site, AC had the fewest.

- Frequency of Valves is:
  - 0.06 / cm in AC (~1 per 17cm)
  - 0.14 / cm in Forearm (~1 per 7cm)
  - 0.16 /cm in Hand (~1 per 6cm)
Valve Findings (Pediatrics)

- 40% of vein segments had at least 1 valve
- 10% had 2 valves
Branch Findings

- The hand had the most branches within 10cm of mark site, AC had the fewest
- Frequency of branches is
  - 0.14 / cm in AC (~1 per 7 cm)
  - 0.16 / cm in Forearm (~1 per 6 cm)
  - 0.20 / cm in Hand (~1 per 5 cm)
- 11% of all vessels had no collateral branches
Branches that would be crossed by 1.0 inch PIV

- The distance to all branches is normally distributed
- The distance to the first branch from a PIV insertion site averages ~3cm
Additional findings that could impact PIV function
Venous collapse: The lumen is difficult to visualize and has no detectable flow peripheral to the PIV. Venous collapse was seen in 46% of veins.
• Circumferential wall thickening was seen in 33% of the veins.
• The vein lumen was compressible with flow on ultrasound distinguishing wall thickness from intraluminal thrombus.
Vein : IV Catheter Size Ratio

- PIV’s are often a close fit in size to host vein
- Clinically, “large” IVs placed in small veins
- Not consistent across nurses
- 30% of sites in adults would not have meaningful flow around 20G PIV
PIV associated thrombus

- Non-compressible, echogenic intraluminal material at PIV tip in 20% of veins
Thrombus and Collapse: Reduced Flow

- Blood flow in vein very sensitive to catheter : vein diameter ratio
- 50% occlusion = 90% flow reduction

Figure 1. A, Velocity profile of laminar flow in the annulus with a centrally placed obstruction. B, Schematic showing diameter of outer and inner cylinders. \(D_{\text{cath}}\) = diameter of the catheter; \(D_{\text{cyl}}\) = diameter of the cylinder.

Summary
Hurdles When Aspirating Blood Through a PIV

Successful blood aspiration from PIV requires one or both:
1. Adequate flow around PIV from behind
2. Access to reservoir/branches in front

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Vision & Challenge: True “1 Stick” Hospitalization

What if you could obtain reliable, non-hemolyzed blood specimens from any PIV?

Suggestions for Practice Change:

Place catheters in ideal venous environments, avoid creating “Restricted Flow” Compartments
- Strong preference for forearm & avoiding AC
- Smaller gauge PIVs (22g > 20/18g)
- Ultrasound guided PIVs, deeper/larger vessels
- Place IV tip near central inflowing branch point, avoiding locations with “blocking” valves

Leverage PIVs for blood collection, minimize venipunctures / vessel depletion
- INS 2016 guidelines “consider obtaining blood samples from indwelling PIVs for Peds, DVAs, bleeding disorders, need for serial tests”
- Consider PIV Blood Collection devices designed to thread flexible tube through PIV into vessel for improved aspiration and patient experience

Reduce reliance and escalation to PICCs, CVCs
- Protect and decrease CVC/PICC accesses by 22% could further reduce CLABSI risk
- Attempt to move all central draws to peripheral line alternatives

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Thank You