Vascular Assessment: Are you doing your due diligence?

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No discussion of off label use will be included in this presentation
Due diligence

- the care that a reasonable person exercises to avoid harm to other persons or their property
Vascular Access Assessment

• What are we assessing for...?
  ▫ Treatment plan?
  ▫ Vessel health?
  ▫ Appropriate device?
  ▫ Risk factors?
  ▫ Other?
INS 2016 standard 26.1

“The appropriate type of vascular access device (VAD), peripheral or central, is selected to accommodate the patient’s vascular access needs based on the prescribed therapy or treatment regimen; anticipated duration of therapy; vascular characteristics; and the patient’s age, comorbidities, hx of infusion therapy, preference for VAD location, and ability and resources available to care for the device.”
INS 2016 standard 26.3

“The VAD selected is the smallest outer diameter with the fewest number of lumens and is the least invasive device needed for the prescribed therapy.”
Short Peripheral IV

- Placed in many patient care settings, both inpatient and outpatient
- No special equipment required, but may use imaging technology such as ultrasound or infrared light
- Most commonly used VAD in the US at an estimated 300M units annually

- Is it easy to place?
- Is it cost effective?
Midline

Definition: A catheter inserted in the upper arm via the basilic, cephalic, or brachial vein, with the internal tip located level at or near the axilla and distal to the shoulder

• Types
  ▫ No touch
  ▫ AST
  ▫ MST
Central lines

Definition: Catheter inserted into a peripheral or centrally located vein with the tip in the superior or inferior vena cava

• Types
  ▫ Acute CVC, PICC, Port, Tunneled
• Insertion site
• Risk/benefit ratio
  ▫ Complications
    • Insertion
      • Dependent on type/location of insertion
    • Post insertion
Preventable complications

- Infiltration?
- Phlebitis?
- Infection?
- Catheter related thrombosis?
Infiltration
Infiltration

- Inadvertent administration of a nonvesicant solution or medication into the surrounding tissue; rated by a standard tool

- INS 2016 standard 46.1
  “The clinician assesses the peripheral and central vascular access device site for signs and symptoms of infiltration and extravasation before each infusion and on a regular basis.....”

Are you doing your due diligence?
Phlebitis
Phlebitis

- Inflammation of a vein; may be accompanied by pain, erythema, edema, streak formation, and/or palpable cord; rated by a standard scale

- INS 2016 standard 45.1 A.
  “Assess regularly, based on patient population, type of therapy, and risk factors, the vascular access sites of short peripheral catheters, midline catheters, and PICCs for signs and symptoms of phlebitis using a standard tool.”

Are you doing your due diligence?
INS 2016 standard 45.1.B

Recognize risk factors that can be addressed

1. Chemical Phlebitis – related to infusate properties, lack of hemodilution, and/or skin antiseptic not fully dried prior to insertion

2. Mechanical phlebitis – related to vein wall irritation, may be caused by to catheter size, movement, insertion trauma, or catheter material

3. Bacterial phlebitis – may be related to emergent catheter insertion and poor aseptic technique

4. Patient related factors – current infection, immunodeficiency, diabetes, lower extremity insertion (except in infants) and age $\geq 60$
Infection
CLABSI vs. CR-BSI

- **CLABSI**
  - A laboratory confirmed, primary bloodstream infection (BSI) in a patient with a central line in place for more than 2 calendar days before the development of the BSI and the BSI is not related to an infection at another site.

- **CR-BSI**
  - A clinical definition used when a catheter is identified through specific laboratory testing to be the source of the BSI.
## Rates of Intravascular Device-Related BSI By Type of Devices *


<table>
<thead>
<tr>
<th>Device</th>
<th># of studies</th>
<th># of catheters</th>
<th># of IV days</th>
<th># of BSIs</th>
<th>per 100 devices</th>
<th>Per 1,000 IVD-days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peripheral IV catheters</td>
<td>110</td>
<td>10,910</td>
<td>28,720</td>
<td>13</td>
<td>0.1</td>
<td>0.5</td>
</tr>
<tr>
<td>PICCs (Inpatient &amp; OP)</td>
<td>15</td>
<td>3566</td>
<td>105,839</td>
<td>112</td>
<td>3.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Short term non-tunneled catheters with CHG/silver</td>
<td>18</td>
<td>3367</td>
<td>54,054</td>
<td>89</td>
<td>2.6</td>
<td>1.6</td>
</tr>
<tr>
<td>Tunneled CVC</td>
<td>29</td>
<td>4512</td>
<td>622,535</td>
<td>1013</td>
<td>22.5</td>
<td>1.6</td>
</tr>
<tr>
<td>Implanted port</td>
<td>14</td>
<td>3007</td>
<td>983,480</td>
<td>81</td>
<td>3.6</td>
<td>0.1</td>
</tr>
<tr>
<td>Dialysis catheters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temporary</td>
<td>16</td>
<td>3066</td>
<td>51,840</td>
<td>246</td>
<td>8</td>
<td>4.8</td>
</tr>
<tr>
<td>Long-term</td>
<td>16</td>
<td>2806</td>
<td>373,563</td>
<td>596</td>
<td>21.2</td>
<td>1.6</td>
</tr>
</tbody>
</table>

*An analysis of 200 published studies. Data collected from 1966 - 2005*
### HAI Progress Report

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>CLABSI</td>
<td>3,655</td>
<td>8%</td>
<td>50%</td>
<td>0.50</td>
</tr>
<tr>
<td>Nat’l Baseline: 200%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAUTI</td>
<td>3,791</td>
<td>5%</td>
<td>0%</td>
<td>1.00</td>
</tr>
<tr>
<td>Nat’l Baseline: 2009</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSI, Abdominal Hysterectomy</td>
<td>3,225</td>
<td>5%</td>
<td>17%</td>
<td>0.83</td>
</tr>
<tr>
<td>Nat’l Baseline: 200%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSI, Colon Surgery</td>
<td>3,377</td>
<td>5%</td>
<td>2%</td>
<td>0.96</td>
</tr>
<tr>
<td>Nat’l Baseline: 200%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MRSA Bacteremia</td>
<td>3,849</td>
<td>4%</td>
<td>13%</td>
<td>0.87</td>
</tr>
<tr>
<td>Nat’l Baseline: 2011</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. difficile Infections</td>
<td>3,994</td>
<td>4%</td>
<td>8%</td>
<td>0.92</td>
</tr>
<tr>
<td>Nat’l Baseline: 2011</td>
<td></td>
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</table>

*The number of hospitals that reported to NHSN and are included in the SIR calculation. This number may vary across HAI types; for example, some hospitals do not use central lines or urinary catheters, or do not perform colon or abdominal hysterectomy surgeries.

†Nat’l baseline time period varies by HAI type. See first column of this table for specifics.

Key Strategies for Minimizing CLABSIs

- Standardization of clinical processes where practice variation may lead to increased risk of CLABSIs

- Specialized teams for consistent high quality clinical outcomes (ex. Vascular Access Team)

- A process in place to identify/assess patients with indwelling central line

- Bundling practices
Developing a Bundle

- A central line insertion-and-maintenance bundle is a group of evidence-based preventive practices and technologies that produce better outcomes when implemented collectively than when implemented individually.

- A bundle will only be effective to the degree that it addresses the actual origins of CLABSI. It must include efforts to combat the formation of biofilm, because it is now well established that CLABSI develop as a result of bacteria colonizing on catheter walls.
When Can Central Line Bundles Succeed?

• Dedicated, specially trained teams to conduct and/or oversee all line insertions & maintenance*


  * Single center study – may not be representative of all institutions

• **Standardized**, Evidence Based Protocols (Bundle) including:
  - Insertion Checklist
  - Central Line Cart Inventory
  - Hand Hygiene
  - Maximal Barrier
  - Daily Necessity Checks (early line removal)
  - Site preparation with Chlorhexidine
  - Site Selection (avoiding femoral lines)

What is missing?

Could there be additional emphasis on care-and-maintenance?

• CVCs may be in place for a week or longer, and will be accessed by nurses numerous times.
• Lines left in place more than 1-2 weeks have a longer care-and-maintenance phase which may present numerous opportunities for infection.
• It was recently reported that over 70% of all CLABSIs reported to the NHSN by Pennsylvania acute care hospitals in 2010 occurred more than five days after insertion, suggesting that infection prevention lapses likely occurred in the post-insertion care and maintenance of the CVCs.

What is missing?

A comprehensive bundle should address care and maintenance as thoroughly as it does catheter insertion.
Compliance to guidelines can be challenging...

<table>
<thead>
<tr>
<th>Central Line Bundle Initiative</th>
<th>Presence of a Policy</th>
<th>Adherence to Policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insertion Checklist</td>
<td>92%</td>
<td>52%</td>
</tr>
<tr>
<td>Hand Hygiene Monitoring</td>
<td>94%</td>
<td>62%</td>
</tr>
<tr>
<td>Maximal Barrier for Insertion</td>
<td>96%</td>
<td>62%</td>
</tr>
<tr>
<td>Chlorhexidine</td>
<td>97%</td>
<td>71%</td>
</tr>
<tr>
<td>Selecting optimal site</td>
<td>91%</td>
<td>46%</td>
</tr>
<tr>
<td>Daily necessity checks</td>
<td>87%</td>
<td>37%</td>
</tr>
</tbody>
</table>


Are you doing your due diligence?
Catheter related thrombosis
Catheter Associated Venous Thrombus

A secondary vein thrombosis related to the presence of a CVAD; includes the presence of an extraluminal fibrin sheath encompassing all or part of the CVAD’s length, with a mural or veno-occlusive thrombosis overlying the fibrin sheath; may be located in deep veins or superficial veins when placed for CVAD use.

Infusion Therapy Standards of Practice (2016). *Journal of Infusion Nursing*, S147
Catheter-Related Thrombosis

**Intraluminal Occlusion**
- Occurs when blood refluxes into catheter
- Adherent to the inner lumen of the catheter but not to the vessel wall
- Can result from inadequate flushing
Catheter-Related Thrombosis

Fibrin tail or flap
- Extends from the catheter tip and blocks the catheter lumen during aspiration
- Infusion may be possible, but aspiration is not
Catheter-Related Thrombosis

Fibrin sheath or sleeve
- Forms when fibrin adheres to the external catheter surface
- May completely cover the opening of the catheter tip
Catheter-Related Thrombosis

Mural Thrombus

- Forms when the catheter rubs against a vessel wall
- Catheter may adhere to the vessel wall
- May form at the entry site, along the catheter path, or at the catheter tip
Catheter-Related Deep Vein Thrombosis

- A blood clot that forms *on a vein* where a vascular catheter has been positioned. Deep veins in the upper extremity include the brachial and axillary veins.

- Mean of 8-9 days from PICC insertion to DVT diagnosis.
Symptomatic vs. Asymptomatic DVT

- **Symptomatic DVT:**
  - A minority of catheter-related DVTs present with symptoms
  - For PICCs this may include swelling (“edema”), redness, and/or pain in the catheterized arm

- **Asymptomatic DVT:**
  - A majority of catheter-related DVTs are “clinically silent” and NOT associated with symptoms
  - These DVTs pose similar clinical risk
## Acute CVCs and DVTs

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Title and Source</th>
<th>Study Type</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kujir, R. et al. (2012)</td>
<td><em>Indian Journal of Critical Care Medicine</em>, 16(1), pp 17-21.</td>
<td>prospective observational study</td>
<td>Thrombus found in 33% (33 of 100) of patients with right IJ CVC.</td>
</tr>
<tr>
<td>Frizzelli, R. et al. (2008)</td>
<td><em>Intern Emergency Medicine</em>, 3, pp 325-330</td>
<td>prospective study</td>
<td>48% (386 of 815) of patients with IJ CVCs had ultrasound proven DVT.</td>
</tr>
<tr>
<td>Wu, X. et al. (1999)</td>
<td><em>Journal of Clinical Anesthesia</em>, 11, pp 482-485</td>
<td>prospective study</td>
<td>56% (45 of 81) of patients with IJ CVCs had ultrasound proven thrombi. 56% of those were sleeve-shaped, 44% were compact thrombi.</td>
</tr>
<tr>
<td>Timsit, JF, et al. (1998)</td>
<td><em>Chest</em>, 114, pp 207-213</td>
<td>prospective, multicenter study</td>
<td>33% (69 of 208) of patients with either IJ or subclavian acute CVCs had ultrasound proven DVT. The rate was higher with the IJ approach at 41%. Authors also found a <strong>2.62 fold higher rate of CRBSI when thrombus was present.</strong></td>
</tr>
<tr>
<td>Karnik, R. et al. (1993)</td>
<td><em>Clinical Cardiology</em>, 16, pp. 26-29</td>
<td>prospective study</td>
<td>63.5% (40 of 63) of patients with IJ CVCs had ultrasound proven DVT.</td>
</tr>
</tbody>
</table>
How does a DVT form?

- The inner-most layer of the vein is endothelium (tunica intima)
  - Single layer of smooth, flat endothelial cells
- Any trauma that roughens endothelial lining encourages thrombin formation
  - Insertion Needle
  - Guidewire
  - Microintroducer
  - Catheter during insertion
  - Indwelling catheter/catheter movement
  - Infusates
RBC trapped in platelet and fibrin mesh

Activated Platelets

Resting Platelets
Risk factors for DVT Formation

• “Virchow’s Triad”: Three well established risk factors that increase thrombus risk:

  Endothelial Injury: damage to the endothelium causes activation of the body’s clotting mechanisms
  Circulatory Stasis: Slowing of blood flow and flow disturbance can activate clotting and thrombus formation
  Hypercoagulability: Some disease states and genetic disorders place some patients at higher risk for thrombus formation
Examples of Specific Risk Factors

- **Endothelial injury:**
  - Trauma
  - Surgery
  - Mechanical injury (including both skilled and non-skilled placement of a vascular access device and dwell)
  - Chemical injury (ex: meds with pH extreme)
  - Malpositioned central line tip
Examples of Specific Risk Factors

• Circulatory Stasis:
  ▫ Immobility (bedrest, stroke, fatigue, etc.)
  ▫ Many illnesses and medical conditions (dehydration, sedation, etc.)
  ▫ Presence of a catheter in the vein (stasis and flow disturbance)
Examples of Specific Risk Factors

• Hypercoagulability:
  ▫ Many disease states such as cancer and its treatment, sepsis, diabetes, ESRD, tissue damage such as trauma
  ▫ Genetically inherited conditions
  ▫ Variable platelet function between individuals
It is not uncommon for patients in the acute care setting to have one or more of these risk factors putting them at risk for DVT formation.

Careful assessment of these risk factors is essential prior to adding a CVC or PICC.
INS 2016 standard 52.1.A

Assess risk factors for thrombosis PRIOR to CVAD insertion.

Risk factors include

- Hx of DVT
- Presence of chronic diseases associate with hypercoagulable state
- Surgery or trauma
- Critically ill
- Known genetic coagulation abnormalities
- Pregnancy
- Extremes of age
- Hx of multiple CVADs, especially traumatic or difficult insertions and presence of other intravascular devices

Are you doing your due diligence?
Which Risks Can Be Managed?

Patients’ underlying risk factors

- Need for central venous access and indwelling vascular device
- Hypercoagulability, inherited or acquired
- Pre-existing disease states and co-morbidities
- Blood stasis associated with immobility, dehydration, surgery, etc.
Which Risks Can Be Managed?

Endothelial injury at insertion:

Use of ultrasound guidance provides

- Real-time visualization of venipuncture
- Can help reduce risk of back wall puncture
- Access veins of upper arm can help to reduce mechanical phlebitis associated with antecubital insertion
- Skilled Clinicians

Are you doing your due diligence?
Which Risks Can Be Managed?

Stasis and flow disturbance:
- Catheter gauge vs. lumen size
- Use of ultrasound for measurement of vein to catheter ratio
- Tip placement

Are you doing your due diligence?
Catheter size matters

Catheter size matters

INS 2016 standard 52.1

- For PICCs, measure the vein diameter, using ultrasound before insertion. Choose a catheter with a catheter vein ratio of <45%
  - Italian Group for the Study of Long-term Central Venous Access Devices (GaVeCelt) suggests at ratio of no greater than 33% with tourniquet off (Emoli et. al. 2014)

- Ensure CVAD tips are located in the lower third of the SVC or cavoatrial junction as tips located in the mid-to-upper portion of the SVC are associated with greater rates of DVT

- Measure the upper arm circumference before insertion of a PICC and when clinically indicated to assess presence of edema and possible DVT

Are you doing your due diligence?
To Pull or Not to Pull

- Recently published study shows that patients who get a DVT from one PICC have an 86% chance of developing another DVT when that PICC is removed and one is immediately placed in a new vein
  

- Published CHEST (2012) guidelines recommend NOT pulling a PICC with diagnosed UE-DVT if central access is still clinically necessary

  9.3.1 For most patients with UEDVT in association with an indwelling central venous catheter, we suggest that the catheter not be removed if it is functional and there is an ongoing need for the catheter (Grade 2C)

Due Diligence

Compliance

Assessment

Knowledge

Skill
QUESTIONS?
References


- Infusion Therapy Standards of Practice (2016). *Journal of Infusion Nursing*, 38(1S)


