An insertion bundle for thrombosis prevention

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Risk factors for CRT

1 - the patient
2 - the disease
3 - the VAD
4 - the insertion technique
The role of the insertion technique

Catheter-Related Central Venous Thrombosis: The Development of a Nationwide Consensus Paper in Italy

Costantino Campisi, MD, Roberto Biffi, MD, and Mauro Pittiruti, MD on behalf of the GAVeCeLT Committee for the Consensus

38 | JAVA | Vol 12 No 1 | 2007
Q2 Is there an ideal insertion technique for minimizing the risk?

No randomized trials had investigated the relationships between insertion techniques in the long term setting and central venous thrombosis rate.

Prospective, not randomized, studies had suggested a relationship between minimal insertion damage to vein wall, as obtained with US guidance, and low rate of subsequent thrombotic events.

**Strength C Recommendation**

A lower-diameter catheter and a single lumen might be protective against the risk of central venous thrombosis. When the number of therapies demands a multiple-lumen catheter, the number of lumens used should be minimized.

**Strength B Recommendation**
Thrombosis is avoided by the use of insertion techniques designed to limit damage to the vein, including:

- Ultrasound guidance at insertion
- Choice of a catheter with the smallest caliber compatible with the infusion therapy needed
- Position of the tip of the catheter at or near to the atrio-caval junction

B grade recommendation
Prevention of CRT

Though CRT is basically a multifactorial phenomenon, a relevant number or risk factors are related to the VAD choice and to the insertion technique.

Introducing an insertion bundle which optimize the insertion technique may reduce the risk of CRT.
The GAVeCeLT insertion bundle for preventing CRT

1. Appropriate choice of the vein
2. Appropriate technique of venipuncture
3. Adequate position of the tip
4. Proper securement
An insertion bundle for preventing CRT

1. Appropriate choice of the vein
Avoid veins with obvious reduction of caliber due to intrinsic or extrinsic abnormalities
As regards PICCs...

Respect the current contraindications to PICC insertion:

- Avoid arms with previous axillary node dissection
- Avoid arms with reduced mobility due to neurological or orthopedic issues
- Avoid arms with venous thrombosis
- etc......
Left or right?

- Some evidence suggests that CICCs inserted on the right side may have less risk of CRT.


- Such evidence cannot be extended to PICCs.
Other insertion technique issues...

In order to avoid the risk of venous thrombosis, this panel suggests that the external diameter of the catheter should not exceed 1/3 of the internal diameter of the vein.
That’s maybe the most important factor

Match the VAD caliber with the vein caliber:

- Inner vein diameter should be at least three times the catheter diameter

- Particularly important when dealing with small veins:
  - PICCs in adult
  - Any central VAD in children and neonate
The Effect of Catheter to Vein Ratio on Blood Flow Rates in a Simulated Model of Peripherally Inserted Central Venous Catheters

Thomas P. Nifong, MD; and Timothy J. McDevitt, PhD

Venous Catheters

Thomas P. Nifong, MD; and Timothy J. McDevitt, PhD
Background: Catheter-related thrombosis is a common complication in all anatomic sites, especially when smaller veins of the upper extremity are considered. It is presumed that the presence of a catheter within the lumen of a vein will decrease flow and potentially create stasis, and clinical data suggest that the size of the catheter impacts thrombosis rates. We sought to determine, both mathematically and experimentally, the impact of catheters on fluid flow rates.

Methods: We used fluid mechanics to calculate relative flow rates as a function of the ratio of the catheter to vein diameters. We also measured the flow rate of a blood analyte solution in an annular flow model using diameters that simulate the size of upper extremity veins and commonly used peripherally inserted central catheters (PICCs).

Results: We compared each of the derived relative flow rates to the experimentally determined ones for three cylinder sizes and found a correlation of $r^2 = 0.90$. We also confirmed that the decrease in fluid flow rate with each successive catheter size is statistically significant ($P < .0001$).

Conclusions: Our results demonstrate that fluid flow is dramatically decreased by the insertion of a centrally located obstruction. Assuming that blood flow in veins behaves in a similar manner to our models, PICCs, in particular, may substantially decrease venous flow rates by as much as 93%.

Abbreviations: CR-DVT = catheter-related DVT; PDE = partial differential equation; PICC = peripherally inserted central catheter
Venous stasis
Catheter size relative to vein size

<table>
<thead>
<tr>
<th>Vein</th>
<th>Initial Flow</th>
<th>2 Fr</th>
<th>4 Fr</th>
<th>6 Fr</th>
<th>8 Fr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cephalic (4 mm)</td>
<td>10</td>
<td>5</td>
<td>3</td>
<td>1.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Brachial (5 mm)</td>
<td>25</td>
<td>13</td>
<td>9</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Basilic (6 mm)</td>
<td>52</td>
<td>29</td>
<td>21</td>
<td>15</td>
<td>9</td>
</tr>
<tr>
<td>Axillary (8 mm)</td>
<td>164</td>
<td>100</td>
<td>79</td>
<td>62</td>
<td>47</td>
</tr>
<tr>
<td>Subclavian (10 mm)</td>
<td>400</td>
<td>256</td>
<td>212</td>
<td>175</td>
<td>143</td>
</tr>
</tbody>
</table>

Nifong TP & McDevitt T. CHEST Published online before print February 24, 2011
As regards PICCs:

- **3Fr** PICCs = 9Fr (3mm) vein or larger
- **4Fr** PICCs = 12Fr (4mm) vein or larger
- **5Fr** PICCs = 15Fr (5mm) vein or larger
- **6Fr** PICCs = 18Fr (6mm) vein or larger

Catheter diameter (in Fr) should be equal or inferior to the vein diameter (in mm)
The same is for VADs in children and neonates
An insertion bundle for preventing CRT

2. Appropriate technique of venipuncture
No randomised trials have so far investigated the relationship between different insertion techniques in the long-term setting (percutaneous vs venous cut-down, US guided vs anatomic landmark techniques) and central venous thrombosis rate.

Prospective studies suggest a relationship between minimal insertion damage to vein wall and low rate of thrombosis.

Strength C Recommendation
**Use ultrasound!**

*International evidence-based recommendations on ultrasound-guided vascular access*

Table 6: Recommendations regarding sterility using ultrasound guidance and prevention of infectious and mechanical complications using ultrasound-guided cannulation

<table>
<thead>
<tr>
<th>Domain code</th>
<th>Suggested definition</th>
<th>Level of evidence</th>
<th>Degree of consensus</th>
<th>Strength of recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>D8.S1</td>
<td>Sterile techniques should always be used during the placement of a vascular access device, including hand washing; sterile full body drapes; wearing of sterile gowns, gloves, caps and masks covering both the mouth and nose. Probe and cable sterility have to be maintained using sterile gel and appropriate probe and cable shields</td>
<td>A</td>
<td>Very good</td>
<td>Strong</td>
</tr>
<tr>
<td>D8.S2</td>
<td>Ultrasound guidance should be used in order to decrease the rate of CRBSI in adults and children</td>
<td>C</td>
<td>Very good</td>
<td>Strong</td>
</tr>
<tr>
<td>D8.S3–4</td>
<td>A multi-faceted strategy, including the use of ultrasound guidance with specific preventive and educational measures and the promotion of good practices applied by both medical and nursing staff, is suggested in order to reduce the incidence of CRBSI</td>
<td>B</td>
<td>Good</td>
<td>Strong</td>
</tr>
<tr>
<td>D8.S5</td>
<td>Ultrasound guidance should be used to avoid cannulation of thrombotic sites</td>
<td>A</td>
<td>Very good</td>
<td>Strong</td>
</tr>
<tr>
<td>D8.S6</td>
<td>Ultrasound guidance, by reducing puncture attempts, technical failure rates and mechanical complications, has to be preferred because of a reduced incidence of catheter-related thrombosis</td>
<td>A</td>
<td>Very good</td>
<td>Strong</td>
</tr>
</tbody>
</table>
Use ultrasound

“... adoption of ultrasound guidance may have a significant favourable impact on the risk of catheter contamination and catheter related infection and on the risk of catheter related venous thrombosis”

(from SOR guidelines, 2008)
Use Ultrasound!
Use microintroducer kits

Always: for CICCs, PICCs, FICCs – both in adults and children
An insertion bundle for preventing CRT

3. Adequate position of the tip
Catheter tip position as a risk factor for thrombosis associated with the use of subcutaneous infusion ports

- 45.2%
- 19%
- 4.2%
- 1.5%
- 5.6%

References:
- Petersen Am J Surg 1999
- Luciani, Radiology 2001
- Puel, Cancer 2003
- Melina Verso, J Clin Oncol 2003
- Caers, Support Care Cancer 2005
Which is the role of the position of the catheter tip?

In many prospective studies, tip position emerged as the main independent prognostic factor for malfunction, thrombosis and reduced duration of the device.

In oncology patients, the atrial-caval junction is apparently the optimal position of the catheter tip, as it minimizes the risk of central venous thrombotic events.

Strength B Recommendation
2008 SOR guidelines for the prevention and treatment of thrombosis associated with central venous catheters in patients with cancer: report from the working group

P. Debourdeau¹, D. Kassab Chahmi², G. Le Gal³, I. Krieger⁴, E. Desruennes⁵, M.-C. Douard⁶, I. Elalamy⁷, G. Meyer⁸, P. Mismetti⁹, M. Pavic¹, M.-L. Scrobohaci¹⁰, H. Lévesque¹¹, J. M. Renaudin¹² & D. Farge¹³ on behalf of the working group of the SOR

primary prevention of CVC-associated thrombosis in patients with cancer

standards.

1 The distal tip of CVC should be placed at the junction between the superior vena cava and the right atrium.
Q5 What is the role of tip position?

UPDATE

All new guidelines agree that an uncorrect tip position is a major risk factor for CRT
As regards PICCs....

- Tip position is particularly critical during PICC insertion
- Simple use of ‘landmark’ measurements results in high rates of tip malposition
- Use of post-procedural x-ray results in accepting many ‘sub-optimal’ tip positions
- The current best practice is to use intra-cavitary EKG for real time, intraprocedural verification of the correct tip position
Use intracavitary EKG!
An insertion bundle for preventing CRT

4. Proper securement
Proper securement

- A ‘mobile’ VAD is more prone to exert mechanical trauma on the vein wall at the puncture site.
- This has been proven for CICCs (Timsit) and for PIVs
- It is likely to be relevant also for PICCs
Proper securement = multimodal

1. Proper choice of the exit site
2. Glue at the exit site
3. Sutureless device
   - Adhesive to skin
   - Anchored subcutaneously
4. Transparent dressing
Proper choice of the exit site

Maximal stabilization:

- midarm

- infraclavicular area

Avoid exit site at midneck!
Proper choice of the exit site

Maximal stabilization:

- midarm
Proper choice of the exit site

Maximal stabilization:

- infraclavicular area
Glue

Glue is great.

- Stops bleeding from the exit site
- Stabilizes the catheter
- Protects from bacterial contamination

AND:

- It is inexpensive
- It has no contraindication
Glue
Sutureless devices

- They should be used for any VAD

- At present, three options:
  1. Devices with skin adhesion
  2. Devices ‘in-built’ in the dressing
  3. Devices which are anchored subcutaneously
     - May be the most reliable for securing the VAD and preventing any movement
Sutureless devices

- Skin adhesion
Sutureless devices

- Included in the dressing
Sutureless devices

- Anchored subcutaneously
Transparent dressing

- Transparent dressings are to be preferred not only because protective against bacterial contamination, but also because of the catheter securement they offer

(see EPIC guidelines 2014)
Tunneling?

Tunneling has a potential role in reducing the risk of CRT:

- It may allow to puncture a vein of appropriate caliber, even if in a site not ideal for dressing
- It may allow to obtain an ideal exit site in a proper location
- It may help in stabilizing the catheter
Tunneled PICC in adult patient
Tunneled FICC in adult patient
Tunneled CICC in adult patient
Tunneled CICC in a child
Insertion-bundle to prevent CRT

PICC insertion
1) Proper choice of the vein
2) US-guided venipuncture + microintroducer kit
3) Intracavitary EKG for intraprocedural tip location
4) Glue + sutureless device + transparent dressing
Insertion-bundle to prevent CRT

CICC insertion in a neonate
1) Proper choice of the vein
2) US-guided venipuncture + micro-introducer technique
3) Tip verification by intracavitary EKG
4) VAD securement: tunneling + glue + sutureless device + transparent dressing
Clinical experience with power-injectable PICCs in intensive care patients

Mauro Pittiruti, Alberto Bratti, Davide Celentano, Massimiliano Pomponi, Daniele G Biasucci, Maria Giuseppina Annetta and Giancarlo Scoppettuolo

See related Letter by Zampieri,

http://ccforum.com/content/16/2/425

89 PICCs in ICU patients – CRT 3%
Does this bundle work?

Journal of Parenteral and Enteral Nutrition

Catheter-Related Complications in Cancer Patients on Home Parenteral Nutrition: A Prospective Study of Over 51,000 Catheter Days
Paolo Cotogni, Mauro Pittiruti, Cristina Barbero, Taira Monge, Augusta Palmo and Daniela Boggio Bertinet
JPEN J Parenter Enteral Nutr published online 20 September 2012 DOI: 10.1177/0148607112460552

The online version of this article can be found at:
http://pen.sagepub.com/content/early/2012/09/18/0148607112460552

165 PICCs in cancer patients – CRT 0 %
Does this bundle work?

Support Care Cancer
DOI 10.1007/s00520-014-2387-9

ORIGINAL ARTICLE

Peripherally inserted central catheters in non-hospitalized cancer patients: 5-year results of a prospective study

Paolo Cotogni · Cristina Barbero · Cristina Garrino · Claudia Degiorgis · Baudolino Mussa · Antonella De Francesco · Mauro Pittiruti

269 PICCs in cancer patients – CRT 1.1 %
Does this bundle work?

A prospective, randomized comparison of three different types of valved and non-valved peripherally inserted central catheters

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² Day Hospital of Oncology, Catholic University Hospital, Rome - Italy
³ Department of Infectious Diseases, Catholic University Hospital, Rome - Italy

180 PICCs in cancer patients – CRT 0.5 %
Conclusions

1) Catheter-related thrombosis should not be seen as a ‘heaven-sent’, inevitable complication: most of the times, CRT is due to ‘bad choices’ of the clinician (inappropriate choice of the VAD and/or inappropriate insertion/maintenance technique and/or inappropriate use of the VAD)
Conclusions

2) The philosophy of ‘targeting zero’ should be applied to ALL COMPLICATIONS: not only to infective complications, but also to insertion-related complications, lumen occlusion, VAD dislodgement, and – last but not least – catheter related thrombosis.
Conclusions

3) Prevention of CRT may be harder than infection prevention in some respects (we cannot control the patient’s predisposing factors; we might need pharmacological prevention) but it may be easier, too (as most of the iatrogenic factors favoring CRT can be prevented by a proper insertion bundle).
Take home message

This is the GAVeCeLT bundle for CRT prevention:

1. Proper choice of the vein
2. Minimal trauma during venipuncture
3. Appropriate tip location
4. Proper securement

PLEASE, TRY THIS AT HOME ...
DON’T TRY THIS AT HOME!
My venous access team...
Thank you for your attention!

mauropittiruti@me.com