We are from a 173-bed community hospital with vascular access nurses (VAN) inserting adult PICCs since 1992. Our proposal to allow VAN interpretation of PICC tip location on chest radiograph (CXR) was denied in 2008, so we continued with established practice: radiologists (Rad) read the CXR and then directed VAN to advance or withdraw catheter based on Rad’s personal opinion regarding optimal tip location. The Rad’s report often conflicted with VAN’s understanding of best practice for tip placement. Tips thought by VAN to lie at the cavo-atrial junction (CAJ) were often read by Rad as “in the right atrium” (RA), and ordered to be withdrawn several centimeters (cm). Tips reported by Rad as “good position” might be located in the proximal or mid superior vena cava (SVC), with complications of those positions experienced by some of our patients. We sought to establish common ground between our departments regarding ideal tip location and the best method to consistently report that location.

BACKGROUND

OBJECTIVES

1. To receive an objective, measurable report on central line tip location.
2. To enable VAN to position PICC in the ideal location recommended by governing bodies and current literature.

PROCESS

Before meeting with Rad, we researched the literature to determine optimal tip location. We developed a presentation that covered in depth the complications of malpositioned lines, especially tips in the upper half of the SVC. In addition, we offered the following guidelines, measuring methods, and effects of body position:

1. Guidelines for central line tip location from governing bodies:
   - 2011 INS (Infusion Nurses Society): SVC near its junction with RA
   - 2011 ONS (Oncology Nurses Society): Distal third of SVC
   - 2010 SIR (Society of Interventional Radiology): CAJ region or RA; 2 vertebral bodies below carina
   - 2009 ESPEN (European Society of Parental and Enteral Nutrition): Lower third of SVC, at CAJ, or in the upper portion of RA
   - 2006 NKF (National Kidney Foundation): SVC/RAA junction or RA
   - 2004 ASPEN (American Society of Parenteral and Enteral Nutrition): Lower SVC adjacent to RA
   - 1998 NAVAN (now Association for Vascular Access): Distal SVC close to CAJ
   - 1994 FDA CVC Working Group: Lower third of SVC, not in RA

2. Methods for measuring tip distance from the anatomical structures that are visible on CXR: the following authors used imaging studies to confirm the accuracy of suggested measurements:
   - Aslany 1998 (MRI): Tip 2.9 cm below right tracheobronchial angle (TBA) will be above CAJ
   - Mahlon 2007 (CT): Tip 4 cm below carina will be near CAJ
   - Baskin 2008 (CT): CAJ is located 2 vertebral units below carina (vertebral units average 2 cm each)
   - Verhey 2008 (CT): CAJ is 1-2 cm below SVC/right atrial appendage (RAA) junction or 5 cm below carina
   - Wirsing 2008 (TEE): Tip to carina distance < 5.5 cm will be extra-atrial in 80% of patients
   - Ridge 2013 (gated CT): Carina averages 4 cm above CAJ

3. The effects of patient position on tip movement led us to question whether the ideal tip location should be CAJ on the upright CXR. Over the years, we had experienced three monitored patients developing arrhythmias soon after PICC placement. All tips were at or slightly below RAA on upright CXR. When supine and side-lying, two patients showed repeated runs of ventricular tachycardia, and one sustained a supraventricular tachycardia. Arrhythmias stopped when these PICCs were withdrawn 2-3cm. These may be rare events, but in an effort to “do no harm”, we sought to locate our PICC tips above the CAJ when the patient is upright, on inspiration, and with arm adducted.

<table>
<thead>
<tr>
<th>BODY POSITION</th>
<th>PICC tip moves UP</th>
<th>PICC tip moves DOWN</th>
</tr>
</thead>
<tbody>
<tr>
<td>BREATHING</td>
<td>4cm</td>
<td>4cm</td>
</tr>
<tr>
<td>TORSO</td>
<td>3cm</td>
<td>3cm</td>
</tr>
<tr>
<td>ARM</td>
<td>2cm</td>
<td>2cm</td>
</tr>
</tbody>
</table>

EXPIRATION

INSPIRATION

SUPINE

ABDUCTED (away from body)

ADDUCTED (along the torso)
CONCLUSIONS

Our vascular access and radiology departments implemented these changes February 1, 2014. Standardizing the reporting of tip location has improved Rad-VAN relations by reducing conflict and ambiguity. Objective, measurable tip location reports and clear guidelines for tip placement have streamlined the clinical workflow for VAN.

So far, we have not had difficulty identifying the carina on CXR. If that occurs, we plan to use the RAA or vertebral bodies as points of reference. We recognize the imprecision inherent with the AP (anterior-posterior) CXR used for our insertion views, and look forward to having ECG guidance technology in the future. However, the distance-from-carina method will continue be useful for reporting tip location on any subsequent CXR. Notably, this method is also being used to determine tip location for centrally inserted central lines, which to date are inserted only by physicians at our institution.

Patients always benefit when different departments are “on the same page” and meet each other’s expectations. We feel that this is what we accomplished here. We now have one consistent way to document and report central line tip location across the patient care continuum– to hospital, outpatient, and home health staff. We seek to stay current with new guidelines and literature regarding best practice for line tip location, and plan to institute more improvements to our practice whenever indicated.

RESULTS

- After our presentation to the radiologists, the chief of radiology recommended the carina as point of reference to report tip location: “We’ll tell you how far from the carina the tip is, and you put it where you want.”
- We developed the following VAN flowchart to guide final PICC tip placement, taking into consideration the position tolerated by patient during CXR. Note: in our practice, insertion CXR is done stat and we stay with the patient, maintain the sterile field, and assess the digital CXR before sending to Rad for official interpretation.

(Repeat CXR needed because entrance to azygos vein typically lies above carina at TBA 4,10,13-15)