Organization: Sinai Hospital of Baltimore

Solution Title: Efficacy of using ECG-based technology to confirm tip location when placing a PICC

Focus Area: Vascular Access Team (VAT), PICC placement focusing on the adult population

Program Project Description:

Peripherally inserted central catheters (PICC) are inserted via the basilic, brachial or cephalic vein above the anticubital fossa. According to the Infusion Nurses Society standards of practice is that the termination of the distal tip must be confirmed to be in the lower one-third of the Superior Vena Cava (SVC) to the junction of the SVC and the right atrium. (Infusion Nurses Society, 2011). Due to the advent of ECG-based technology, the VAT endeavored to develop a trial to evaluate whether this would prove to be a safe and reliable alternative to a chest x-ray. This alternative was first described in 1949 by Von Hellerstein et al. later in 1959 by Hughes R and Magovern G, 1984 Colley P and Artru A, and in 1988 Artru A and Colley P. ECG guidance for tip positioning has now been used in Europe for over 20 years and is widely used in Germany and Italy for positioning of CVCs.

Problem/Baseline: Prior to the trial, data showed that >5% (157 in fiscal year 10-11) of all PICC’s that were placed at Sinai by the VAT were malpositioned. A malposition can include catheters being threaded into the Jugular, Ìnominate, Subclavian vein or into the Atrium. Each malposition required the inserter to reposition the catheter, obtain another chest x-ray or to refer the patient to Interventional Radiology where the patient would have the catheter re-positioned with the use of fluoroscopy. With each invasive procedure the patient was not only exposed to increased radiation, a possible delay in treatment but also had an increased risk for infection.

Goals:

- Decrease exposure to radiation.
- Assure that the PICC was placed correctly the first time which decreases any need for repositioning. This in turn can decrease the risk for a Central line Associated Blood Stream Infection (CLABSI)
- Minimize the time from placement to use, allowing treatment to be initiated immediately.
Process:

In order to define the feasibility of using an ECG-based technology as a means to determine tip position we developed a trial to study whether placement was accurate using this system. The process began with an interdisciplinary collaboration between the VAT, our Director and the Radiologists at Sinai.

- A plan was developed to compare placement while using the ECG-based technology and a traditional chest x-ray.
- In January 2012, VAT nurses completed an online module plus a four-hour didactic session with hands-on practice, taught by the manufacturer's clinical educator.
- From January 30th to February 9th, the clinical educator also provided education during live insertions by the team members, during which competency with the system was validated on actual PICC placements.
- After each team member was certified to place a PICC and verify tip placement using the ECG-based technology a chest x-ray was taken to verify tip placement.
- The results were analyzed during a 3 month period. The study included adult patients that were eligible for inclusion. Patients with non-distinguishable P-waves, due to conditions such as atrial fibrillation, atrial flutter and those that were 100% paced were excluded.

Solution Identified:

Product: All of the PICC’s placed were open ended 4 FR single lumen, 5Fr double lumen or 5Fr triple lumen polyurethane catheters loaded with wire that had a magnetic tip that served as the intravitary ECG lead. The real-time guiding devices used were the SiteRite 6 ultrasound system, the Sherlock II tip location system (TLS) and the Sherlock 3CG® tip confirmation System.

Procedure:

Once we locate a vein using the ultrasound, leads are placed to evaluate the baseline ECG waveform for a distinguishable P-wave. The PICC is then inserted and tracked using the Sherlock II TLS. As the intravascular ECG signal appears we are able to compare changes with the P-wave. As the PICC tip nears the SA node the P-wave height increases. A maximum P-wave without the presence of a negative deflection indicates the catheter tip is in the CAJ (Cavoatrial Junction). If the catheter tip advances beyond this point a negative deflection in the P-wave will be seen. The inserter monitors the intravascular ECG while adjusting the position of the catheter tip until appropriate location is achieved. When the catheter tip is in the CAJ we can then print out a rhythm strip displaying the intravascular ECG at maximal amplitude.
Measurable outcomes:

Pilot Data: During the trial period, (Jan 30, 2012 to April 10, 2012), there were a total of 155 PICC placed by the vascular access team. Of the total 155 placements, 125 were inserted using the ECG confirmation system. In the remaining 125 patients where ECG was used, 120 (96%) were confirmed, by Chest x-ray, to be in the lower SVC at or near the CAJ. The remaining 5 (4%) were initially described by the radiologist as in the right atrium and were retracted per their instructions. In 2 of the 5 cases, a follow-up CXR, after adjustment, showed the tip of the PICC to be in the mid or upper SVC, which appeared to indicate that in fact, the catheter tip was at the CAJ initially. No repeat CXR was done on the other 3.

Since the beginning of the project we have placed 1625 PICC’s. In fiscal year 13 we were able to place 87.5% of our PICC’s using ECG-based technology and in fiscal year 14 were able to place 88.02% of our PICC’s using the technology. The remainder of the lines placed used the traditional method of a Chest x-ray for confirmation due to a lack of P-wave. During traditional placement using a chest x-ray we determined that the average time from placement to confirmation was 160 minutes. With ECG-technology the time from placement to confirmation on those lines was instantaneous.

For those patients eligible for placement using the ECG-based technology the benefits are numerous:

- During the past two fiscal year(s), using ECG-based technology we have successfully decreased the need for radiation in approximately 87.8% of our patients.
- The trial period, during which time we required an x-ray for verification, and ongoing audit show the accuracy of placement. Manipulations of the catheters are not necessary after placement using the ECG-based technology.
- We decreased the time from initiation of PICC placement to usage by approximately 110 minutes. This can decrease delay in treatment and ultimately increase patient satisfaction
- Thus the ECG-based technology has proved to be an accurate and reliable method for tip location for PICC placements.

Sustainability:

A standard policy was developed and on April 30, 2012, routine CXRs, for PICC tip position after insertion was eliminated when ECG guidance is utilized. We have continued to use ECG-based technology to determine tip location of our PICC’s.

To ensure ongoing monitoring of the process, an audit mechanism was developed to assess and maintain our competency with the ECG-based technology. The audit is an on-going process which randomly assess tip placement. To date the audit has shown one PICC read as Atrium and subsequently received a chest x-ray post retraction. This catheter was then read as mid-SVC which could interpret the initial placement as correct.
Role of Collaboration and Leadership:

The process continues with an interdisciplinary collaboration between the VAT, our Director and the Radiologists at Sinai. Our nurses are the only dedicated team within Sinai placing PICC’s at the bedside. The 4 nurse team was able to learn and become confident with the process quickly. After initial allocation of funds for the system and training, the core members of the VAT were able to then train and/or establish competency with any new employee. The core members of the team also began a Clinical Center for Training (CCT) in affiliation with the manufacturer, C.R. Bard, to educate other nurses around the country in the use of our ECG-based technology. Additionally, to track data prospectively, a database is maintained to capture each line placement.

Innovative Attributes

The use of ECG-based technology has allowed the team to use the most up to date technology to assure that placement of the PICC is accurate the first time. The technology has since been improved to add the Diamond technology to our system. The Sherlock 3CG® TCS upgrade shows a Yellow, green and red on the intravascular waveform. As the tip of the catheter approaches the SA node the waveform turns green. The waveform then turns red as the tip of the catheter enters the RA. This has allowed us to further fine tune our placement.

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References


