Successful Implementation of Electrocardiographic-Guided PICC Placement with a Nurse-Comprised PICC Team

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Abstract

PURPOSE
The use of electrocardiographic (ECG) guidance has been shown to be safe and effective for the placement of peripherally inserted central catheters (PICCs), port catheters, and other central lines (1). The goals of this study were to evaluate the Sherlock 3CG® Tip Confirmation System (TCS) in the placement of PICCs (using chest radiographs as the gold standard) and then to successfully implement use of the Sherlock to reduce the utilization of chest radiographs for PICC positioning at our institution.

METHODS
From October 2011 to April 2012, we analyzed the positions of PICCs placed with the Sherlock 3CG® TCS. A chest radiograph performed after each PICC placement was interpreted by two independent observers (AKP, BLM). A catheter tip located within the superior vena cava or cavoatrial junction was considered successful placement of a PICC.

The study comprised a total of 247 PICC placements from 221 patients. Exclusion criteria included atrial fibrillation, atrial flutter, or lack of a discernible p-wave. Sixty-two PICC placements (3/65 excluded) were included in Phase I of the trial. PICC team training in Phase I included a 1-hour PICC refresher course, 3-hour online certification course, and 1-hour didactic course. Hands-on training with a clinical nurse specialist was voluntary.

One hundred forty seven PICC placements (35/182 excluded) comprised Phase II of the trial. This time, however, the hands-on training with the clinical nurse specialist was mandatory. The clinical nurse specialist observed 5 PICC placements to her satisfaction prior to each PICC nurse operating independently.

RESULTS
Results of phase I were considered unsatisfactory, with 83% of PICCs placed in the SVC or cavoatrial junction. Results of Phase II were considered satisfactory, with 96% PICC placement into the SVC or cavoatrial junction.

CONCLUSIONS
The FDA-approved Sherlock 3CG® Tip Confirmation System (TCS) is an effective device for guiding PICC placement to the SVC or cavoatrial junction. Sufficient educational training is important to achieve a successful transition from radiographic confirmation to usage of the Sherlock 3CG® TCS. The Sherlock 3CG® TCS device has generally eliminated the need for radiographic confirmation of PICC placement in our patient population, except for patients with atrial fibrillation, atrial flutter, or lack of a discernible p-wave.

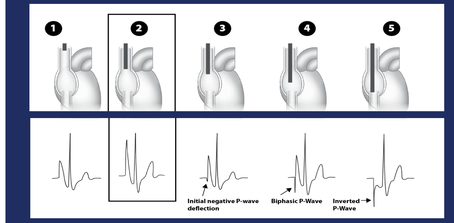
Introduction

Previous investigators have demonstrated that an ECG electrode placed on a peripherally inserted central catheter assists in accurate line placement by assessing p-wave deflection (Figure 1). Deflection of the p-wave continually increases until the sinoatrial (SA) node in the right atrium is reached. Distal to the SA node, the p-wave starts to deflect below the baseline (negative deflection). An initial negative deflection is an indicator of the distal tip of the central venous catheter traversing the cavoatrial junction to enter the right atrium (2).

The Sherlock 3CG® Tip Confirmation System (Bard Access Systems, Salt Lake City, UT) is an FDA-approved device for the placement of PICCs. Like its predecessor, the Sherlock® II Tip Location System (Figure 2, Bard Access Systems, Salt Lake City, UT), the Sherlock 3CG® TCS employs a magnetic tracking device across the chest that assists in confirming appropriate placement of the PICC. The Sherlock 3CG® TCS additionally uses ECG tracking to guide the PICC towards the cavoatrial junction and combines PICC tip placement technology into select Site~Rite Ultrasound systems.

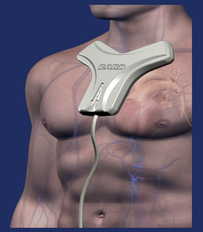
Researchers have previously demonstrated the efficacy of central line placement using ECG guidance (1); however, many hospitals have yet to adopt this method as standard of care. We evaluated the Sherlock 3CG® Tip Confirmation System (TCS) for the placement of PICC lines using chest radiographs as the gold standard. We then successfully implemented the Sherlock at our institution and reduced the utilization of chest radiographs for PICC positioning.

Figure 1

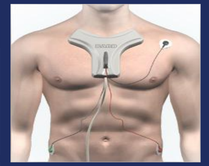


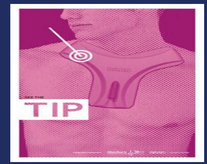
As the intracavitary ECG lead approaches the cavoatrial junction, the amplitude of the p-wave increases. Once the lead is beyond the cavoatrial junction, a negative p-wave deflection occurs. Maximum p-wave amplitude is determined to be approximately at the cavoatrial junction.

Figure 2



Prior to the advent of the Sherlock 3CG® TCS, the Sherlock® II Tip Location System (TLS) utilized a metallic sensor placed across the patient's chest to detect PICC position (i.e. to determine whether the tip was directed cranially or caudally).





Sherlock® II Tip Location System (TLS)
+
ECG GUIDANCE
(with use of ultrasound)
=
Sherlock 3CG® Tip Confirmation System

Sherlock 3CG® Tip Confirmation System (TCS) with Site~Rite Ultrasound Monitor

Online Demo Training Module

Snapshot of the online training module for the Sherlock 3CG® TCS

Methods/Results

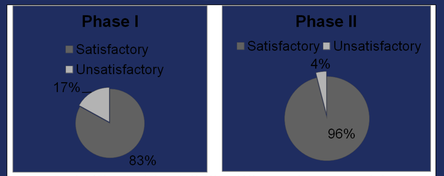
Informed consent was obtained from each patient prior to PICC placement. Patients with atrial fibrillation, atrial flutter, or lack of an identifiable p-wave were excluded from the trial since alterations of cardiac rhythms that change the normal presentation of a P-wave limit the use of ECG tip confirmation technology. Standard contraindications for non-ECG guided PICC placement were applied, such as increased risk of bleeding complications (INR > 2.5 or a platelet count < 50). Participants included both inpatients and outpatients. The age range of the patient population was from 15 to 100, with mean age of 62. Two hundred forty seven PICC lines in 221 patients were evaluated. After exclusions, 209 PICCs comprised the data.

At our institution, 7 nurses on a PICC team perform the PICC placements in patients not deemed at increased risk for bleeding. Each nurse in this trial had at least 1.5 years of PICC placement experience. PICCs were placed by 6/7 nurses comprising the PICC team. Prior to using the Sherlock 3CG® TCS system, each PICC nurse underwent training that consisted of a 1-hour PICC refresher course, 3-hour online certification course, and 1-hour didactic course, which 4/6 PICC nurses voluntarily attended. The same 4 PICC nurses received one-on-one training with the Bard nurse specialist. After completion of Phase I training, 65 PICCs were placed from October to December 2011. Three placements were excluded (in accordance with the exclusion criteria above), leaving a total of 62 PICCs placed. During phase I, 83% of PICCs were deemed to be in a satisfactory (i.e. cavoatrial junction/SVC) location.

Phase II of the trial involved an increased emphasis on training. Contrary to Phase I, all aspects of training were mandatory in Phase II and all 7 PICC nurses completed Phase II training. The three PICC nurses who did not complete the initial 1-hour didactic classroom course and one-on-one training with the Bard nurse specialist during Phase I were able to complete this training with another experienced Bard nurse specialist. During phase II, the Bard nurse specialist observed PICCs placed by each of the 7 nurses and helped one-on-one with any deficiencies or questions. She then observed 5 PICC placements to her satisfaction prior to each PICC nurse operating independently. After completion of Phase II training, 182 PICCs were placed from January to April of 2012. Thirty-five PICCs were excluded (in accordance with the exclusion criteria above), leaving a total of 147. Phase II demonstrated 96% satisfactory placement (Figure 3).

Radiographic assessment of PICC location for each trial was performed by 2 independent physicians, a radiology resident and an experienced chest radiologist (AKP, BLM). Neither the resident nor chest radiologist reviewed reports prior to interpretation.

Figure 3



Results of Phase I and Phase II with 83% and 96% correct placement, respectively.

Discussion

Prior to use of the Sherlock 3CG® TCS device, our institution required chest radiographic confirmation of PICC placement, which delayed patient treatment and subjected patients to radiation, albeit small (portable=17mR and PA/lateral=20mR at our institution). PICC patients also sometimes required more than one radiograph if their PICC was deemed to be in an unsuitable location that necessitated repositioning.

From November 2012 to May 2013, 567 PICCs were placed at our institution. Of these, we used the Sherlock 3CG® TCS in the placement of 437 PICCs. Radiographic confirmation was obtained in 109 PICC placements despite the use of the Sherlock 3CG® TCS for reasons that included an unclear baseline rhythm and complicated/uncertain PICC placement. However, Sherlock 3CG® TCS use resulted in a 75% reduction in chest radiographs on the patients for which it was used. Our institution utilized the Sherlock® II TLS prior to the Sherlock 3CG® TCS. The cost of upgrade to the Sherlock 3CG® TCS was offset by savings from reducing numbers of chest radiographs for confirmation. With continued experience using the Sherlock 3CG® TCS, we believe that radiographic confirmation will decrease further.

The major difference in training between Phase I and Phase II was the increased one-on-one training provided by a Bard nurse specialist in Phase II. We believe that the improved accuracy in PICC placements in Phase II was the direct result of this training. In particular, PICC team at our institution encompassed nurses with a wide range of experience in reading electrocardiograms. One of the inherent difficulties in use of the Sherlock 3CG® Tip Confirmation System for PICC placement is the ability to properly interpret the electrocardiogram. Some members of the PICC team were able to learn the ECG-guided system faster than others. The didactic classroom and one-on-one training on PICC placements provided by a Bard nurse specialist helped remedy initial discrepancies among members of the PICC team. If there is a question or concern regarding PICC placement, PICC nurses at our institution continue to order a chest radiograph for confirmation of PICC location. Our research validates the Sherlock 3CG® Tip Confirmation System as an acceptable tool for placement of PICCs, reducing the need for radiographic confirmation. We found that implementation of the Sherlock 3CG® Tip Confirmation System required sufficient dedicated PICC team training.

References

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