Electrocardiogram-Guided Peripherally Inserted Central Catheter Tip Confirmation Using a Standard Electrocardiogram Machine and a Wide-Mouth Electrocardiogram Clip Compared with Traditional Chest Radiograph

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Abstract

Objective: *The purpose of this institutional review board-approved, single-blinded, randomized controlled trial was to evaluate the effectiveness of bedside peripherally inserted central catheter (PICC) tip placement using a nonproprietary electocardiogram (EKG) machine and wide-mouth EKG clip connected to the right arm lead and PICC guide wire. The hospital site in this study was an 800-bed community, nonacademic, Magnet hospital in the southeastern United States.*

Methods: *All patients who provided consent and were eligible for bedside PICC insertion were randomly assigned to either standard PICC insertion or standard PICC insertion plus EKG guidance. Placement was identified by observing for P wave changes, which indicated PICC tip location in relationship to the sinoatrial node in the superior vena cava. After the PICC lines were placed, 2 radiologists blinded to treatment assignment independently reviewed confirmatory chest radiographs. De-identified data were collected and analyzed.*

Results: *One hundred eighty-seven patients participated in this study. Of all patients, 94.6% had a baseline rhythm with a discernable P wave. The time to insert the PICC while using EKG guidance increased by a mean difference of 9 minutes (P = .001). The time to notification of the floor nurse that the PICC was read by a radiologist and ready to use for infusions was not significant between groups. In the control group, 91.8% of PICC lines were placed to completion at the bedside vs 90.2% in the experimental group (P = .710). PICCs placed with EKG guidance were successfully placed with the first attempt or 1 pass (89%; n = 91) vs PICCs placed without EKG guidance (75%; n = 63; P = .01). Of the control group, 40% (n = 34) and of the experimental group, 48% (n = 49) had PICC lines placed within 1.5 cm of the sinoatrial junction. Of the control group, 53% (n = 45) and of the experimental group, 65% (n = 66) had PICC lines placed within 1.5 cm of the sinoatrial junction to 3.0 cm above the sinoatrial junction (P = .10). Of the control group,*

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64.8% (n = 55) and of the experimental group, 82.2% (n = 84) had PICC lines placed within 1.5 cm of the sinoatrial junction to 6.0 cm above the sinoatrial junction (P = .3). Of the control group, 7.1% (n = 6) and of the experimental group, 2.9% (n = 3) had PICC lines placed 6.1 cm or more above the sinoatrial junction. Of the control group, 18.8% (n = 16) and of the experimental group, 8.8% (n = 9) had PICC lines placed too deep in the superior vena cava and below 1.6 cm (P < .05). PICCs inserted with or without EKG guidance statistically had the same amount of chest radiograph images performed (P = .083). Three groups reviewed the chest radiographs to determine the PICC tip location and they agreed to the location 82% of the time and a significant positive correlation between all 3 groups existed. The PICC Team subjectively identified 22 patients as obese. No statistical significance was realized among patients not identified as obese vs those identified as obese.

Conclusions: *The data revealed that the control and experimental groups were equally distributed for baseline demographic characteristics such as sex and age. Importantly, it was determined that 94% of participants had a discernable P wave and were candidates for the use of EKG guidance. The time to insert a PICC line at bedside with the use of EKG guidance increased the procedure time by a mean of 9 minutes; however, the ultimate influence on patient care resulted in a savings of 67 minutes after factoring in an average of 76 minutes for radiograph confirmation. Complications and the need to reposition PICC lines were not found to be significant or vastly different or improved with or without the use of EKG guidance. PICC lines placed with the use of EKG guidance were significantly unlikely to be repositioned. Lastly, it was found that obesity did not play any particular role. Based on these findings, the facility determined that EKG guidance is effective and its use was implemented for all bedside PICC placements in which a P wave was discernable.*

Keywords: *PICC placement, EKG guidance, P wave changes*

Introduction

A peripherally inserted central catheter (PICC) is a catheter inserted into the upper arm above the antecubital fossa and advanced into the central venous system. The current standard of practice dictates the tip of a PICC should terminate in the lower third of the superior vena cava (SVC).[1]

Accurate PICC tip location, within the lower third of the SVC, has been associated with improved PICC-related outcomes.[2] Risks linked with the PICC tip resting short of the lower third of the SVC may include venous thrombosis, vessel perforation, and spontaneous PICC tip malposition. Arrhythmias, tricuspid valve damage, and cardiac tissue erosion may result from an overadvanced PICC tip.[3,4]

If a PICC is placed at bedside, the tip's location may not be apparent during the process. PICC tip placement may be determined using body surface landmarks and then, after the insertion process, confirmed by standard chest radiograph, which is then reviewed by a radiologist. PICCs are typically placed at bedside or inserted in an interventional radiology setting. If the PICC is placed in an interventional radiology setting, confirmation of the tip's location is determined using fluoroscopy.

The current practice of bedside PICC placement without additional equipment relies on anthropometric estimates and body surface landmarks. This method provides bedside clinicians with a general length of catheter to advance. The proposed vessel is cannulated and the catheter is advanced along the desired vein tract. Before the initiation of infusion therapy the tip location is determined radiographically. Limitations when postinsertion chest radiographs are used for PICC tip verification include a delay before intravenous therapy initiation because of the time involved for the radiologists to interpret the chest radiographs and communicate the results to nursing staff. Real-time bedside tip location would be beneficial because of the potential for a postinsertion line reposition or adjustment after the chest radiographs are interpreted by radiologists. Cumulative radiation exposure of patients and hospital staff must also be considered. Discrepancies in chest radiograph interpretation due to inconsistent boney or soft tissue landmarks, nonstandard terminology used to describe the location of the tip in the SVC, body positioning during chest radiograph exams (especially if performed in the bed), and patient height and weight have been documented.[5]

In 2008, Pittiruti et al[2] conducted 2 studies. During these studies, the authors used a stopcock system connected to an alligator clip and a standard electrocardiogram (EKG) monitor. The study consisted of 12 patients in whom the EKG and chest radiograph methods were used. The authors reported that all PICCs were placed in the SVC at the junction of the right atrium. The authors also noted that in 3 cases, the surface landmarks used to measure the expected length of the catheter were off by > 2 cm. The second study involved 6 patients using closed-ended PICCs.[6] Five of the PICCs were properly placed and the sixth patient was eliminated due to inability to identify the needed waves on the EKG. The authors identified disadvantages, such as if the P wave cannot be visualized, the method cannot be used. However, the authors also determined this