Original research article

JVA The Journal of Vascular Access

Vascular access unit: Six-years experience report in France

The Journal of Vascular Access
1–6

DOI: 10.1177/11297298221080228
journals.sagepub.com/home/jva
SAGE

Michele Scimò[1], Irene Vallecorsa[2], Antoine Cini[3], Delphine Cabelguenne[4] and Vincent Piriou[2]

Abstract

Background: The role of nurses in peripherally inserted central catheters (PICC) placement has been limited in France. Having a fully trained nurse-led PICC team can positively impact nursing profession and make better use of valuable human and economic healthcare resources. It can also improve the standards of patient's care, procedural experience, and safety.

Aim: The aim of this article is to report the successful outcomes of nurse-led PICC team performed over a 6-year period from a single central hospital in France.

Methods: The authors reviewed all PICCs insertions performed by their trained nurse led team between 2014 and 2019. All quantitative and qualitative variables were considered: the patients admitted, the type of PICC inserted, overall procedural time, the mentor's help, the insert failures, the number of punctures required, the procedural pain utilizing Visual Analog Scale (VAS), any procedural complications, chest X-rays needed, the follow up to the eighth day (D8).

Results: From 2014 to 2019, 12,687 PICC were inserted with 128 failed procedures (1%). In 2019, 73% of procedural insertion time was less than 10 min. The request of support rapidly decreased to 2 calls/month. More than 90% of procedures were associated with mild pain (VAS $\leqslant$ 3). After the first month of training, 81% of all procedures were performed with a single insertion puncture. Accidental artery puncture during procedure was 0.5%. The authors found room for improvement, progressing from 97% in the first year to 99% in 2019. Furthermore, the authors found that only 1.85% of all catheters developed local infection within D8, and only 0.83% evolved in vein thrombosis. Total bloodstream infection was at 0.1%.

Conclusion: The authors report successful outcomes from data collected during the 6-year period demonstrating clear benefits of a nurse-led vascular access team with regard to system wide efficiencies and patient satisfaction.

Keywords

Peripherally inserted central catheters, vascular access, trained nurse-led PICC team, safety, complications

Date received: 28 May 2021; accepted: 25 January 2022

Introduction

Safe and reliable central vascular access is an essential invasive procedure when a variety of treatments such as irritants, vesicants, parenteral nutrition, and long term intravenous therapy must be delivered to patients. Traditionally, inserting central venous catheters has been under the domain of medical practitioners (anesthetists, radiologists, surgeons) due to the potential procedural complications and technical complexities. In recent years the increased demand and medical shortage of practitioners has led to the adoption of trained-nurse insertion teams.[1–8,13,14] Since 2009, in France, cooperation protocols between

[1]Vascular Access Unit, Department of Critical Care, Hospices Civils de Lyon, Hôpital Lyon Sud, Pierre-Bénite, France
[2]Department of Anesthesiology and Reanimation, Hospices Civils de Lyon, Hôpital Lyon Sud, Pierre-Bénite, France
[3]Department of Internal and Vascular Medecine, Hospices Civils de Lyon, Hôpital Lyon Sud, Pierre-Bénite, France
[4]Department of Pharmacy, Hospices Civils de Lyon, Hospices Civils de Lyon, Pierre-Bénite, France

Corresponding author:
Michele Scimò, Vascular Access Unit, Department of Critical Care, Hospices Civils de Lyon, Hôpital Lyon Sud, 165 Chemin du Grand Revoyet, Pierre-Bénite F-69310, France.
Email: mikscm@gmail.com

health caregivers allowed trained nurses to perform central venous insertions under a proper medical delegation of duty. The first French hospital to create a nurse-trained service for central venous access was Leon Berard Cancer Center in Lyon, France.[1] Following the example and experience of this facility, a similar service has been opened in our hospital (Lyon Sud Hospital Center, France).

The aim of this article is to analyze the results achieved during our experience of the initial 6-year period (from 2014 to 2019).

Materials and methods

When first established, our vascular access unit was composed of four trained nurses from the department of anesthesia plus two medical practitioners as delegates. The increasing demand for central venous access led to additional training of four more nurses, with a further addition of eight nurses and five physician mentors. The need for central venous access was always confirmed and patient's clinical history carefully reviewed prior to the procedure. When initially established, the vascular access team performed only peripherally inserted central catheters (PICC) insertion, however more recently, included the insertion midlines, ports, and Broviac catheter. This article focuses only on the insertion of 4–5 French (Fr) PICCs inserted under ultrasound guidance and utilizing an ECG-based guidance system for tip positioning. The procedure was considered as a failure when the catheter could not be correctly placed in superior vena cava. Post procedural chest X-rays were only performed to check left-side insertions or in the presence of patients with heart rhythms without P-wave.[15,16,18–21,27,29–31] Prior to commencing the procedure, an ultrasound assessment of the superficial and central veins anatomy was performed, using a Rapid Central Vein Assessment approach (RaCeVa).[22] The three most common indications for PICCs were chemotherapy (32.2%), antibiotic therapy (33.8%), and parenteral nutrition (16.4%).

Theoretical and practical training

The process for nurses to be accredited to insert vascular access devices (VADs) in the facility was divided into two parts: theoretical component and clinical training. The theoretical learning was structured in 30 h and it combined multiple components of device insertion and management: clinical indications, pathophysiological and anatomical review, clinical examination and patient assessment, ultrasounds, and chest X-rays interpretation. The clinical training process involved 30 observations of mentors demonstrating various inserting techniques, 30 mentor-supervised insertions, and 30 unsupervised insertions.

Assessing endpoints

The authors report the outcome of PICC insertions performed by their trained nurse team between 2014 and 2019 and the results archived were evaluated considering quantitative and qualitative variables: the number of patients admitted, the amount of PICC inserted, the insertion time, the number of situations requiring mentor's help, the amount of insert failures, the quantity of punctures needed, the evaluation of patient's procedural pain utilizing visual analog scale (VAS), arterial punctures, chest X-rays needed, follow up at D8.

Statistical data analysis

The authors decided to explore each variable of the data series separately, following an univariate time series approach: a sequence of measurements of the same variable collected over month and years. The objective was to determine a model that described our time series. In order to achieve this, the authors used the following time series forecast methods: preliminary graphic analysis (mean, variance, standard deviation); centered moving average for smoothing data (windows width = 12); exponential smoothing; ordinary regressions models. "R^2" describes the ratio of the variable Y explained by the variable X, which is an index of the curve's reliability.

Results

From 2014 to 2019, 17,777 patients were admitted for VADs: Table 1 shows the entire yearly activity and the population studied. In 2014, 1316 patients were admitted for PICC insertion with 38 failed insertions (2.9%), and 6 arterial punctures (0.5%). In 2019 increased demand for VADs led to treat 3840 patients, 2204 for PICCs, the remainder for midlines, totally implantable venous access ports (TIVAPs) and Broviac, with 10 failures (0.5%), and 2 arterial punctures (0.1%).

From 2014 to 2019, the authors received 12,687 patients for PICC insertions with only 128 failed procedures (1%). The insertion time rate remarkably decreased starting from the third month. In 2019, 73% of procedures were performed in less than 10 min (R^2: 0.8014; Figure 1).

Initially important, the request of mentor's help rapidly decreased from an average of six (5.5%) calls per month in 2014 to two (1.2%) calls in 2019 (R^2: 0.9922; Figure 2). To assess patient pain related to PICC insertion a visual analog scale was used (VAS). The authors found more than 90% of procedures being associated with mild pain (VAS $\leqslant$ 3; R^2: 0.9648; Figure 1).

With regard to the amount of puncture needed to insert successfully the PICC, the past first month, one puncture was necessary in 81% of cases, with an ongoing improvement of 89% during 2019 (R^2: 0.8268 ; Figure 1). From the beginning, the authors found the number of incidental artery puncture rate during procedure was very low (0.5%) due to ultrasound needle guide usage (R^2: 0.7631; Figure 1). However they found margin for improvement, progressing from 97% in the first year to 99% in 2019 (R^2: 0.9706; Figure 1).

Table 1. Activity year-on-year and the population studied.

	2014	2015	2016	2017	2018	2019	TOT
Total patients	1323	1885	3386	3539	3804	3840	17,777
Total PICCs inserted	1316	1789	2596	2429	2353	2204	12,687
% Failed procedures	2.89	0.95	1.00	0.66	0.89	0.45	1.01
% Arterial punctures	0.5	0.2	0.1	0.0	0.1	0.1	0.1
Mean age ± SD	58.92 ± 18.14	58.83 ± 18.31	59.28 ± 17.87	58. .90 ± 17.56	59.71 ± 18.08	60.06 ± 16.89	59.28 ± 1.81
% Pz. D8	59.12	44.21	33.82	28.00	19.80	16.38	30.75
% Local infections D8	4.24	1.14	1.37	1.47	1.07	1.11	1.85
% Thromboses D8	0.90	1.26	0.91	0.44	0.86	0.28	0.83
% Bloodstream bacterial infection D8	0.26	0.13	0.11	0.00	0.00	0.00	0.10

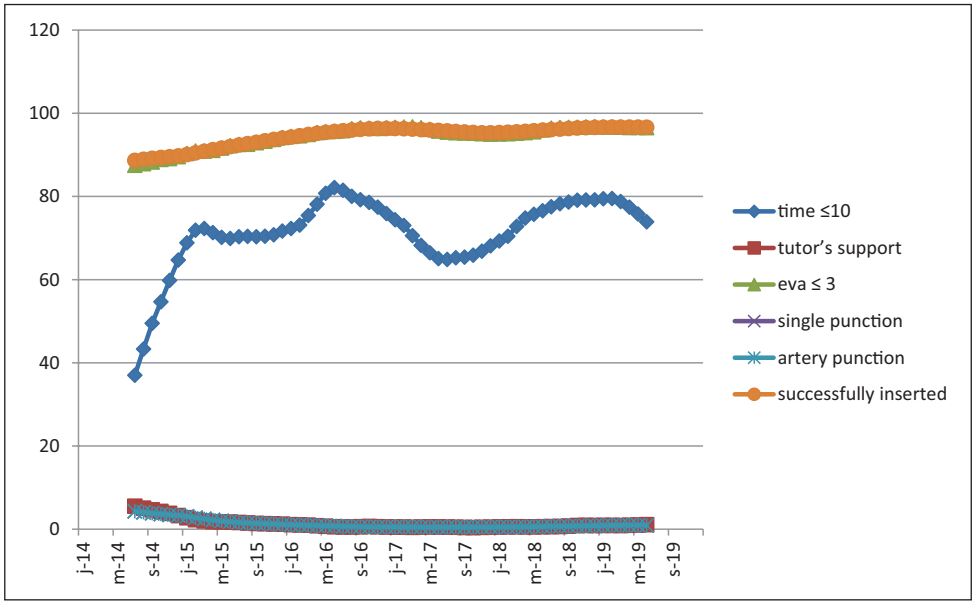

Figure 1. Rate of quantitative and qualitative variable studied.

During our 6-year period of activity, 4061 chest X-rays were performed, 2434 to control right inserted PICC, and 1618 to check on left side catheter. From September 2015 and following international guidelines,[1,15] the authors maintained a post procedural chest X-ray only to check on left side insertions or in presence of patients with heart rhythm problems. In that way 8797 chest X-rays were economized over 12,858 PICCs inserted. A post procedural follow up strategy was designed to evaluate any possible complication in accordance with regional health agency guidelines. A complications report form was collected at D8 (Table 1).

The authors considered the three most common complications associated with PICC insertion: local infection defined as a positive culture of the PICC segment ($\geqslant 10^3$ CFU/ml) with pus emerging from the exit site, without general signs of sepsis and negative blood cultures, thrombosis defined as a thrombus diagnosed with ultrasonography and bloodstream bacterial infections defined as a positive blood culture; although only 31% of all inserted PICC had an appropriate follow-up at D8 linked to the lack of human resources (Table 1). In 2014 they established that only 4% of all placed catheters developed local infection within D8: that percentage, furthermore, decreased at 1% over the years (2019) (R^2: 0.9694 ; Figure 2). At the beginning (2014) the catheter thrombosis percentage was at 0.9%, reducing to 0.3% in 2019 (R^2: 0.5878; Figure 2). Finally, bloodstream infection as a result of

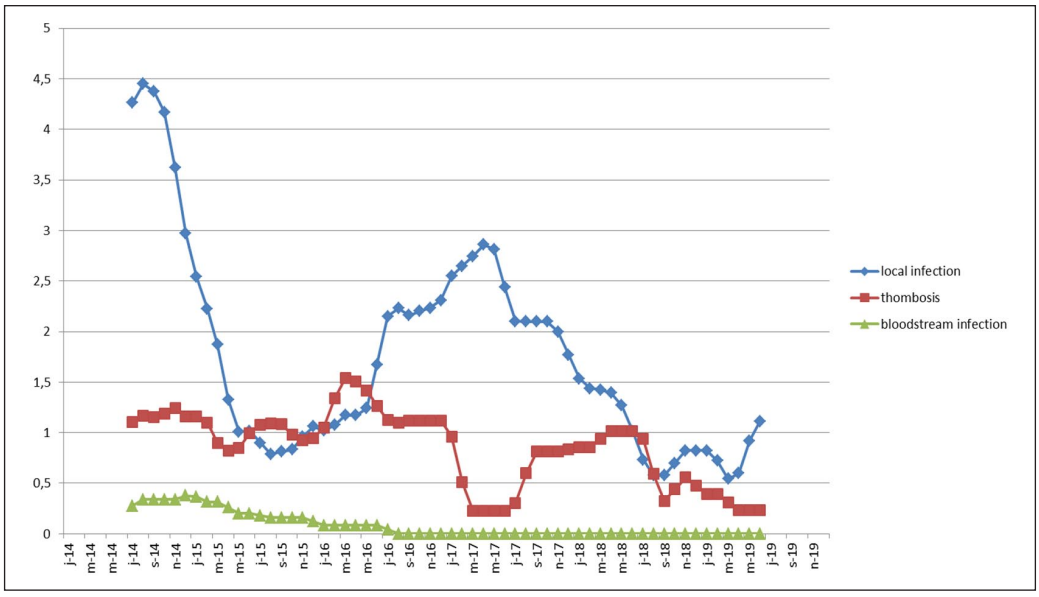

Figure 2. Rate of complications associated with PICC insertion.

PICC insertion was at 0.3% in 2014 and no cases were reported in 2019 (R^2: 0.9813; Figure 2).

Discussion

Increasing demand for PICC placement and shortage of medical staff availability led to create a trained nurse-led team. The specific goal of the dedicated vascular team was to improve hospital efficiency and patients safety, to decrease patients waiting list, to harmonize guidelines and protocols, and finally to promote the appropriate venous access for the right patient, according to his clinical situation. After the training period, once all skills had been acquired, nurses were generally satisfied with their role.[14] Since 2016, the total number of inserted PICCs began to decrease. This descending trend was justified by the introduction of new vascular equipment (TIVAPs, Midline, Broviac) that was meant to replace PICCs, following specific and precise clinical indications. According to the authors' experience a well-trained nurse was able to perform a PICC insertion within 10 min, with a successful one puncture rate up to 89%. Procedural pain was evaluated mild in 96% of patients, using visual analog scale (VAS $\leqslant$ 3): this is a valid instrument in measuring the procedural pain and an index of successful patient management.

This satisfactory performance was achieved using ultrasound and needle guide to minimize multiple punctures, which proved to correlate to more post procedural complications such as arterial punctures (0.1%; 18/12,687). As previously mentioned, these skills were rapidly acquired but in order to be maintained they needed the continuous practice that only a large, dedicated center with more than 1000 central catheters per year could provide.[1,23,24] There have been a number of small studies supporting the role of nursing staff inserting VADs as an organizational solution, resulting in increased efficiency, reduction of cost, and improved clinical care.[9,10]

In addition to the obvious improvement of patients procedural experience, another important aspect correlated to the excellent performance of well trained nurses which resulted, therefore, in a significant decrease in the intervention of mentors. Although initially solicited (with an average of 6 calls/month), by the end of their training, and after a few months of practice, the mentor received an average of only to two monthly calls, a clear expression of total autonomy on behalf of a trained nurse, and consequently, the opportunity to free up valuable medical time.

The creation of a dedicated catheter insertion service run by both medical and nursing staff, improved overall patient care and satisfaction[1–8,13,14,25,26] without exposing them to increased risk of complications.[12] In addition, to further minimize the risk of procedural problems each prescription was re-evaluated by both trained nurse and mentor. They assessed: the nature and duration of the treatment, any thrombosis or venous stenosis documented by a previous ultrasound scan or CT scan, and the presence of altered blood values (neutropenia, platelets, coagulopathies). If a contraindication was found, the prescription was discussed again with the prescribing doctor and possibly changed. Normally the waiting list never exceeded 24–48 h, as each day either one or two time slots were dedicated to emergency cases. Yacopetti et al.,[3] Alexandrou et al.,[4,11] Sainathan et al.,[28] and Krein et al.[12] demonstrated that all PICC inserted by well trained nurses had the same or even less amount of complications than the catheters placed by medical staff. In

any case the number of complications lowered considerably by using ultrasound and ECG-based guidance for tip position. Current evidence suggested that the ECG based method (intracavitary ECG with or without electromagnetic guidance) was a safe and simple procedure with high success rates to track the catheter insertion, to assess, and correct tip position[15,16,18–21,29,30] This equipment minimized the need of radiological post procedural chest X-rays: finally they were still only performed for left-side insertions and to patients without P-wave. This conduct helped economize the use and cost of radiological procedures and most of all it minimized patient X-rays exposure.[15–21,27,29–31]

Another important and expected result was to successfully reduce the risk of procedural complications such as local infections, thrombosis, and bloodstream bacterial infections.

Limits

The principal limits of our study consisted in the underestimation of the resources needed to follow up patients. In fact, due to staff shortages, patient monitoring at D8 was actually very difficult to perform. This problem could, however, be solved with a more active collaboration of the prescribing team or the use of dedicated software or both. The lost patients rate at D8 was important (41% 2014, 56% 2015, 66% 2016, 72% 2017, 80% 2019), Table 1. The year 2020 was not considered as consequence of the COVID-19 pandemic crisis and therefore the necessity of turning most of the competences of hospital nursing staff to other more critical tasks.

Conclusion

Considering 6 years of experience, the benefits from a dedicated vascular access unit were multiple and relevant both in terms of efficiency and productivity. These concepts improved new forms of collaboration between professionals of the healthcare delivery system. The creation of protocols and guidelines helped to standardize and secure procedures, equipment support, and intense training being helpful for the improvement of patient outcome and satisfaction. Entrusting patients to trained nurses represented a gainful strategy in reducing patients waiting lists in a completely safe way, to cut financial costs, and to improve the efficiency of the vascular access service (more than 1000 requests of VADs a year). In France delegation of duty from doctors to nurses is still a possible process, although submitted to strict laws, in order to optimize hospital resources. In light of these findings, the authors encourage and promote the creation of vascular access units all over France.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

According to the French laws about retrospective study, the local Ethical Committee was not solicited.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

ORCID iD

Antoine Cini https://orcid.org/0000-0001-7042-3453

References

1. Rosay H, Cellupica H, Thumazet C, et al. Placement of central venous catheters by nurses. An example of physician-nurses collaboration: PICC and PORT. *Le Praticien En Anesthésie Réanimation* 2014; 18(4): 244–249.
2. Alexandrou E, Spencer TR, Frost SA, et al. A review of the nursing role in central venous cannulation: implications for practice policy and research. *J Clin Nurs* 2010; 19(11–12): 1485–1494.
3. Yacopetti N, Alexandrou E, Spencer TR, et al. Central venous catheter insertion by a clinical nurse consultant or anaesthetic medical staff: a single-centre observational study. *Crit Care Resusc* 2010; 12(2): 90–95.
4. Alexandrou E, Murgo M, Calabria E, et al. Nurse-led central venous catheter insertion-procedural characteristics and outcomes of three intensive care based catheter placement services. *Int J Nurs Stud* 2012; 49(2): 162–168.
5. Ostrowski AM, Morrison S and O'Donnell J. Development of a training program in peripherally inserted central catheter placement for certified registered nurse anesthetists using an N-of-1 method. *AANA J* 2019; 87(1): 11–18.
6. Fournier B, Lecluze J, Tharel L, et al. Nurse-led central venous catheter insertion: a review of a cooperation protocol. *Soins* 2019; 64(836): 13–16.
7. Kollár G, Alizadeh H and Gulyás E. Nurse style of central vein! our experience in the peripherally inserted central venous catheter. *Orv Hetil* 2017; 158(22): 856–863.
8. Bedford E and Waterhouse D. Service development of a nurse-led community-based PICC insertion service. *Br J Nurs* 2017; 26(2): S22–S27
9. Chagas de Assis GL, Mota ANB, Ferreira Cesar V, et al. Direct cost of peripherally inserted central venous catheter insertion by nurses in hospitalized adults. *Rev Bras Enferm* 2021; 74(2): e20190663.
10. Walker G and Todd A. Nurse-led PICC insertion: is it cost effective? *Br J Nurs* 2013; 22(19): S9–15.
11. Alexandrou E, Spencer TR, Frost SA, et al. Central venous catheter placement by advanced practice nurses demonstrates low procedural complication and infection rates: a report from 13 years of service. *Crit Care Med* 2014; 42(3): 536–543.
12. Krein SL, Kuhn L, Ratz D, et al. Use of designated nurse PICC teams and CLABSI prevention practices among U.S. hospitals: a survey-based study. *J Patient Saf* 2019; 15(4): 293–295.
13. Mc Diarmid S, Scrivens N, Carrier M, et al. Outcomes in a nurse-led peripherally inserted central catheter program:

a retrospective cohort study. *Can Med Assoc J* 2017; 5(3): E535–E539.
14. Kelly LJ, Young B and Ellis G. The experiences of nurses who insert central venous access devices. *Br J Nurs* 2013; 22(2): S4–S8.
15. Monard C, Lefèvre M, Subtil F, et al. Peripherally inserted central catheter with intracavitary electrocardiogram guidance: malposition risk factors and indications for post-procedural control. *J Vasc Access* 2019; 20(2): 128–133.
16. Dale M, Higgins A and Carolan-Rees G. Sherlock 3CG® tip confirmation system for placement of peripherally inserted central catheters: a NICE medical technology guidance. *Appl Health Econ Health Policy* 2016; 14(1): 41–49.
17. Keller EJ, Aragona E, Molina H, et al. Cost-effectiveness of a guided peripherally inserted central catheter placement system: a single-center cohort study. *J Vasc Interv Radiol* 2019; 30(5): 709–714.
18. Li J, Chai Y, Zhu Y, et al. Application of intracavitary electrocardiogram classification in peripherally inserted central catheter localization in cancer patients. *J Electrocardiol* 2021; 70: 39–44.
19. Dong HM, Zhu YX, Yin XX, et al. Clinical significance of different atlas of intracavitary electrocardiogram for PICC localization in 961 cases. *Ann Noninvasive Electrocardiol* 2021; 27(1): e12904.
20. Pittiruti M, Scoppettuolo G, Dolcetti L, et al. Clinical use of Sherlock-3CG® for positioning peripherally inserted central catheters. *J Vasc Access* 2019; 20(4): 356–361.
21. Pittiruti M, Pelagatti F and Pinelli F. Intracavitary electrocardiography for tip location during central venous catheterization: a narrative review of 70 years of clinical studies. *J Vasc Access* 2021; 22(5): 778–785.
22. Spencer TR and Pittiruti M. Rapid central vein assessment (RaCeVA): a systematic, standardized approach for ultrasound assessment before central venous catheterization. *J Vasc Access* 2019; 20(3): 239–249.
23. Qian F, Zhong Y and Hannan EL. Relationship between operator and hospital volumes and short-term mortality for percutaneous coronary intervention in New York. *Int J Cardiol* 2019; 293: 91–100.
24. Kinoshita Y, Sugihara T, Yasunaga H, et al. Hospital-volume effects on perioperative outcomes in peritoneal dialysis catheter implantation: analysis of 2,505 cases. *Perit Dial Int* 2018; 38(6): 419–423.
25. Johnson D, Snyder T, Strader D, et al. Positive influence of a dedicated vascular access team in an acute care hospital. *J Am Med Assoc* 2014; 18(4): 244–249.
26. Corcuera Martínez MI, Aldonza Torres M, Díez Revilla AM, et al. Impact assessment following implementation of a vascular access team. *J Vasc Access*. Epub ahead of print 26 December 2020. DOI: 10.1177/1129729820984284.
27. Pittiruti M, Bertollo D, Briglia E, et al. The intracavitary ECG method for positioning the tip of central venous catheters: results of an Italian multicenter study. *J Vasc Access* 2012; 13(3): 357–365.
28. Sainathan S, Hempstead M and Andaz S. A single institution experience of seven hundred consecutively placed peripherally inserted central venous catheters. *J Vasc Access* 2014; 15(6): 498–502.
29. Pittiruti M, LaGreca A and Scoppettuolo G. The electrocardiographic method for positioning the tip of central venous catheters. *J Vasc Access* 2011; 12(4): 280–291.
30. Walker G, Chan RJ, Alexandrou E, et al. Effectiveness of electrocardiographic guidance in CVAD tip placement. *Br J Nurs* 2015; 24(14): 8–12.
31. Tomaszewski KJ, Ferko N, Hollmann SS, et al. Time and resources of peripherally inserted central catheter insertion procedures: a comparison between blind insertion/chest X-ray and a real time tip navigation and confirmation system. *Clinicoecon Outcomes Res* 2017; 7(9): 115–125.