



Peripherally inserted central catheter and costs associated with nursing care: an integrative review

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ABSTRACT

Objective: Analyze the scientific production available on the costs associated with the use of peripherally inserted central catheters in nursing care for hospitalized patients. **Method:** Integrative review in which the search strategy was developed using the PICO strategy, a total of 688 articles were initially found, after reading the title and abstract, 11 articles remained to be read in full, of these, six were included in the review. **Results:** This study's evidence shows that it is important to include data on the consumption of materials, labor, medicines, solutions, catheter maintenance, management of complications, and the depreciation costs of the equipment used during insertion in cost calculations. The use of technology during nursing care reduces the associated costs. The use of ultrasound during catheter implantation showed lower costs compared to blind implantation, due to the lower incidence of complications. The bedside technique proved to be more economical. The total cost cited in the studies ranged from US\$215.68 to US\$881.81. **Conclusion:** Knowing the costs associated with nursing care for peripherally inserted central catheters in hospitalized patients can help optimize supplies, minimize the costs generated for institutions, and improve the quality of care.

Keywords: Education Nursing Care. Catheterization. Peripheral. Vascular Access Devices. Costs and Cost Analysis. Direct Service Costs.

INTRODUCTION

The use of peripherally inserted central venous catheters (PICCs) is intended to benefit patients who need safe venous access for prolonged intravenous therapy (IVT), and is considered a technological advance in the health area, which occurred between 1990 and 2000⁽¹⁾. Since then, it has been widely used in neonatology and pediatrics, intensive care, oncology, geriatrics, home care, and patients with difficult venous access for IVT^(1,4).

Peripherally inserted central venous catheters are centrally located devices inserted through a peripheral vein. Their advantages include prolonged permanence, a reduction in multiple punctures, and they can be inserted at the bedside. In contrast, their disadvantages include

the risks associated with complications inherent to invasive procedures^(2,4). Among the PICC-related complications described by the Infusion Therapy Standards of Practice of the Infusion Nurses Society (INS) are phlebitis, infiltration, catheter-related bloodstream infection (CRBSI), and catheter damage such as rupture, occlusion, and skin damage associated with the dressing⁽⁵⁾.

In order to help insertion and minimize complications, investments have been made in the development of technologies, with significant growth in companies specializing in specific devices and equipment, but operationalization and implementation are dependent on institutional financial support, as well as the training/habilitation of nurses and continuing education for the nursing team involved in caring for patients using PICCs,

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generating costs for institutions⁽⁶⁾.

In Brazil, PICC insertion must be carried out privately by trained and qualified nurses within the scope of clinical practice⁽⁵⁾; the technical and legal attribution for insertion is supported by Federal Nursing Council (COFEN) Resolution 258/2001⁽⁷⁾. In 2017, COFEN Ordinance No. 1090 approved insertion by nurses under local anesthesia and guided by ultrasound, provided they are qualified through professional qualification and/or training⁽⁸⁾. In other countries, no specific qualification is required to perform this puncture technique.

Nursing care is related to the insertion, maintenance, removal, and management of PICC complications in hospitalized patients, considering the chain of processes involved in the use of this device by IVT patients⁽²⁷⁾.

Due to the important role of nurses in terms of care and management within institutions, the scarcity of available financial resources, and the increase in healthcare spending, nurses need to be able to analyze, structure, and synthesize the demands related to healthcare management, as well as organizing the management of human, material, structural, and financial resources involved in the process⁽⁹⁾.

Peripherally inserted central venous catheters are considered high-cost material and remain under intense administrative control in healthcare institutions due to their impact on hospital bills. Therefore, cost analysis can promote the optimization of healthcare actions, making it essential to understand the costs associated with catheter use^(3,10).

Knowing the items that make up the costs associated with PICC nursing care is essential for calculating and managing the costs of health services, as well as guiding decision-making and the allocation of resources consumed^(11,13,14).

Cost management in nursing can be understood as an administrative process aimed at rationalizing resources through cost control and decision-making by nurses, in order to meet the health needs of their clients in accordance with institutional goals⁽¹²⁾.

In view of the scarcity of material/human resources and considering the increase in demand for health services, as well as the challenges and difficulties encountered by public and private paying sources in balancing budgets,

it is extremely important for nurses to deepen their knowledge of "health costs"⁽¹⁴⁾.

In this context, this integrative review was carried out considering that the development and dissemination of studies on the costs associated with nursing care for PICCs in hospitalized patients can generate new knowledge, which is increasingly timely in order to optimize the applicability of the resources available in health institutions, as well as contributing to the improvement of care quality.

In view of the above, the study was carried out with the aim of analyzing scientific production on the costs associated with the use of peripherally inserted central catheters in nursing care for hospitalized patients.

METHODS

This is an integrative review that complied with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) recommendations⁽¹⁵⁾. In keeping with the methodological rigor required to conduct an integrative review, six stages were followed:⁽¹⁶⁾ I) drafting of the guiding question; II) literature search or sampling; III) data collection; IV) critical analysis of the studies included; V) discussion of the results; and VI) presentation of the integrative review.

The guiding question was developed using the PICO strategy, an acronym for Population/Patient/Problem, Interest and Context⁽¹⁷⁾, in which: "P" - hospitalized patients; "I" - costs; and "Co" - peripherally inserted central catheters.

The following guiding question was established as a criterion for stage I: What scientific evidence has been published in the literature on the costs associated with the use of peripherally inserted central catheters in nursing care for hospitalized patients?

The searches were carried out in electronic databases: CINAHL - The Cumulative Index to Nursing and Allied Health Literature; LILACS - Latin American and Caribbean Health Sciences Literature; BDENF - Nursing Database; Web of Science and on the PubMed portal, which includes MEDLINE.

Descriptors in health sciences (DeCS) and their English-language counterparts that make up

the Medical Subject Headings (MeSH) were used, as well as descriptors in Spanish: "patient", "hospitalization", "costs", "direct costs of services", "costs and cost analysis", "health care costs", "central venous catheterization", "vascular access devices", "peripheral catheterization," which were combined with each other using the Boolean operators "AND" and "OR", according to their synonyms - respecting the search characteristics of each database searched.

The inclusion criteria were primary articles published in the last 22 years (between 2001 and September 2023), with no language restriction, and whose methodology showed the calculation of costs associated with nursing care for PICCs in hospitalized patients.

Studies carried out by means of qualitative analysis, ecological studies, theoretical reflections, manuals, health policies, official documents, reports, book chapters, end of course papers, theses, dissertations, reviews of any kind, and studies that did not address the purpose of this study were excluded.

In stage II of the literature search or sampling, the main researcher carried out the search in each database, which took place on September 11, 2023, and resulted in a total of 668 articles. Three stages were then used for identification and selection: identifying the articles in the databases; reading the titles and abstracts; and their eligibility according to the research question. To select the articles after reading them in full, two independent researchers evaluated the studies. If a consensus was not reached, a third reviewer was consulted and, based on their opinion, provided without prior knowledge of the examinations already carried out, the decision was made on whether or not to include the manuscript.

In stage III, in order to detail the information collected from the articles, an instrument designed by the author was used to extract the information after reading it in full, following the recommendations proposed in the literature. The following items were considered essential: identification of the original article (author; level of evidence, title, year of publication, place of study); objective; methodological characteristics, main results, and conclusions.

All the titles and abstracts initially selected were imported into the software State of the Art through Systematic Review (StArt®), a tool developed by the Software Engineering Research Laboratory of the Department of Computing at the Federal University of São Carlos⁽¹⁸⁾.

In stage IV, after synthesizing the results, they were grouped into a synoptic table in which a descriptive analysis was carried out in a careful and detailed manner, and the data obtained was compared with theoretical knowledge in an attempt to integrate the results.

In the sequence, an analysis of the studies was carried out in order to find out the focus of scientific production on costs associated with nursing care for PICCs in hospitalized patients. The following methodological steps were taken at this stage: identification of the guiding question; survey of the literature; critical evaluation of the studies and analysis of the data, thus seeking to provide a methodological organization and apply rigor to the study. Once the analysis had been completed, the relevant elements were summarized in order to portray the theme, as shown in Figure 1.

To classify the level of evidence (LE), seven hierarchical levels were used. Level 1 (strongest) was evidence from systematic reviews, meta-analyses, or randomized clinical trials; level 2 was evidence from well-delineated randomized clinical trials; level 3 was evidence from well-delineated clinical trials without randomization; level 4 was evidence from well-designed cohort and case-control studies; level 5 was evidence from systematic reviews of descriptive and qualitative studies; level 6 was evidence from single descriptive or qualitative studies; and level 7 (weakest) was evidence from expert opinion⁽¹⁹⁾. To classify the LE, we used the design of the studies described by the authors who were included in the sample.

The data was interpreted critically and impartially in order to provide access to the results found, regardless of whether they converged or conflicted with the available literature.

RESULTS

A total of 668 articles were found and, after the selection stages by reading the title and abstract, with subsequent analysis of the full

articles (Figure 1), six articles were selected to make up this review.

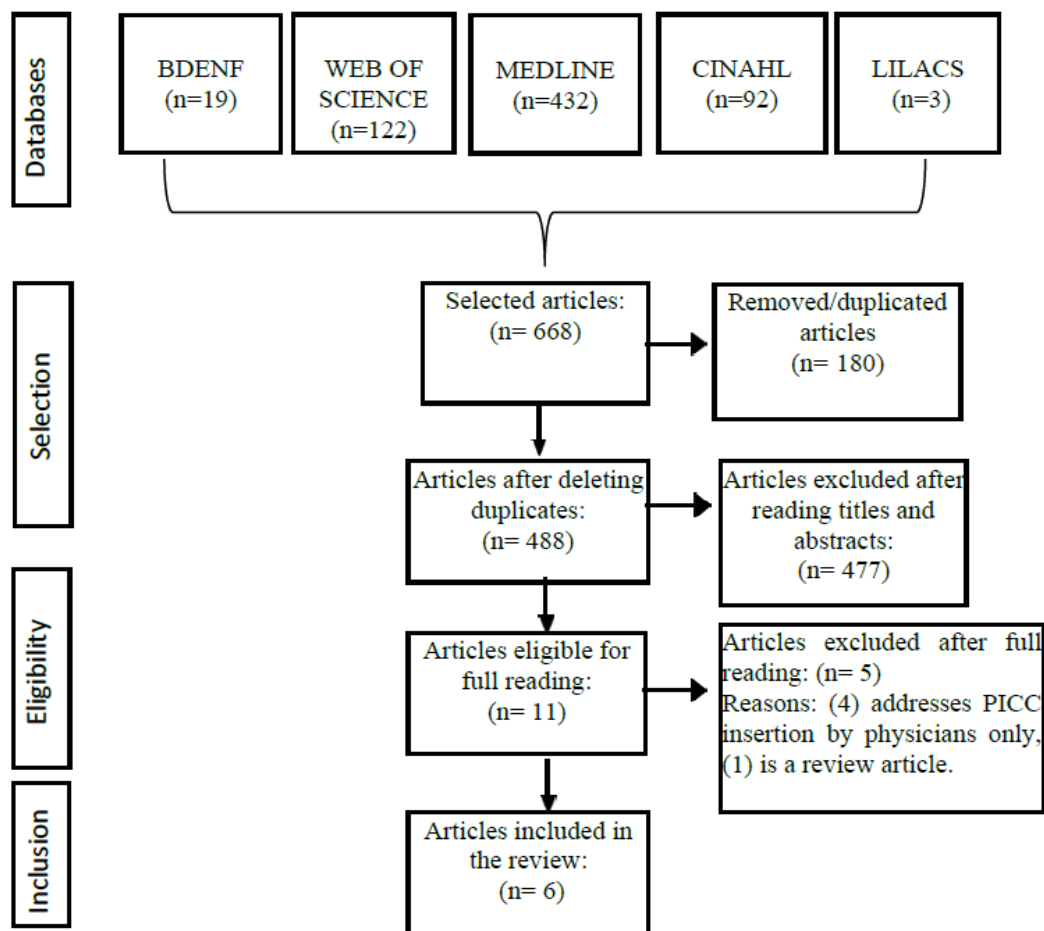


Figure 1. Flowchart of the identification of articles and selection process - Londrina, Paraná, Brazil, 2023

Source:Prepared by the authors, based on the PRISMA model.

The data obtained was then structured into two tables with the main information from the studies. As shown in Table 1, six primary

articles (100%) made up the sample of this integrative review.

Chart 1. Characterization of the six primary articles included in the integrative review according to author, journal, level of evidence, title, year of publication, and place of study - Londrina, Paraná, Brazil, 2023

SI	Author/ Level of Evidence	Title	Year of publication	Place of study
S1	Rotzinger, R. et al. LE: 4.	Placement of central venous port catheters and peripherally inserted central catheters in the routine clinical setting of a radiology department: analysis of costs and intervention duration learning curve.	2017	Sweden/ Germany
S2	Tomaszewski, K. J. et al.; LE: 4	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.	2017	United States

S3	Dong, Z. et al.; LE: 4.	Cost analysis of peripherally inserted central catheter in pediatric patients.	2018	Canada
S4	Pires, A. B. M. et al.; LE: 4.	Direct cost of peripheral catheterization by nurses.	2019	Brazil
S5	Taxbro, K. et al.; LE: 2.	Cost analysis comparison between peripherally inserted central catheters and implanted chest ports in patients with cancer-A health economic evaluation of the PICCPORT trial.	2019	Sweden
S6	Assis, G. L. C. et al. LE: 4.	Direct cost of Peripherally Inserted Central Venous Catheter insertion by nurses in hospitalized adults.	2021	Brazil

Source: Prepared by the authors.

Legend:LE: level of evidence; PICC:peripherally inserted central catheters; PORT: totally implanted chest ports; SI: study identification; S1: study 1; S2:study 2; S3:study 3; S4: study 4; S5: study 5; S6: study 6.

Regarding the levels of evidence (LE), most of the studies showed LE 4 and only one showed LE 2. The costing method of the studies in the sample had no influence on the LE classification.

Table 2 shows that all the articles had well-defined, concise, and clear objectives and described cost variables throughout the PICC study. Two of the publications analyzed came

from retrospective cohort studies, one randomized clinical trial, one cross-sectional study, and two quantitative, exploratory-descriptive case studies. There was a diversity of costing methodologies. As for the place of the studies, the following locations were found: Brazil (2); Sweden/Germany (2); United States (1); Canada (1).

Chart 2. Presentation of the objective, summary of the design/population/sample, results, and outcomes of the six published articles – Londrina, Paraná, Brazil, 2023

SI	Objective	Study type/ population/ sample	Outcome	Conclusion
S1	Carry out a retrospective analysis of CVPC and PICC implantation in a large patient population, including a cost analysis of both methods.	Type of study: Retrospective cohort study. Population: Adults. Sample: 791 procedures.	The cost of inserting the PICC was € 201.68 (US\$ 215.68), considering the costs of the team (labor); materials, and equipment.	Interventional implantation (outpatient/bedside level) is much more cost-effective than surgical implantation.
S2	Evaluate the time and cost of intracavitary ECG screening and blind insertion with chest x-ray tip confirmation for PICC insertions.	Type of study: Cross-sectional, observational study. Population: Adults. Sample: 120 participants.	The cost of insertion with intracavitary ECG was US\$273 and blind insertion with confirmation by chest x-ray was US\$367. The costs of intracavitary ECG; chest x-ray; materials; costs of materials to correct catheter failures/complications; team costs during insertion and management of complications were considered.	The use of intracavitary ECG has proven to be superior to blind insertion with chest x-ray confirmation, it has the potential to increase the productivity of PICC insertion at the bedside, detect complications early, and reduce costs.
S3	To identify the costs associated with PICC from a social point of view and to identify the factors that are associated with the total costs of the catheter.	Type of study: Retrospective cohort study. Population: Hospitalized children. Sample: 469 children.	The adjusted cost per pediatric patient per day of catheter stay without hospitalization was US\$362.7. The costs of materials, complications, prior assessments by nurses, removal of the catheter, and home care were considered.	Direct costs associated with implementation accounted for 96.4% of total costs.

S4	Measuring the cost of the PICC insertion procedure by nurses in a pediatric and neonatal intensive care unit.	Type of study: Quantitative, exploratory-descriptive, single-case study. Population: Children and neonates. Sample: 100 observations.	The cost of PICC insertion was US\$326.95 in neonates. The costs of catheter kits, materials, medicines, solutions, team labor, and procedure time were considered.	The cost of materials was representative and is related to the catheter kits that had the highest unit cost, followed by the second highest cost, which is the direct labor of the nurse.
S5	Carry out a clinical trial for the economic evaluation of central venous catheters, comparing the costs associated with PICC and PORTOCATH in cancer patients.	Type of study: Randomized clinical trial. Population: Adults. Sample: 399 participants.	The cost was € 824.58 (US\$881.81) for PICC insertion and € 662.34 (US\$708.31) for PORTOCATH insertion. The costs with the team; catheter; equipment; pharmaceuticals; materials; management of complications including hospitalization; removal; duration of the procedure, and depreciation of equipment were considered.	PICC has a higher cost when compared to PORTOCATH, but in care practice it has specific indications. The difference in cost is mainly driven by PICC-related complications.
S6	Analyze the cost of the PICC insertion procedure by nurses.	Type of study: Single case study with a quantitative approach Population: Adults. Sample: 139 observations.	The cost per PICC insertion in adult inpatients was US\$286.04. The costs of the catheter and puncture kit for ultrasound use; materials; medicines; solutions; transparent film, occlusive connector; and professional labor were considered.	The total cost of inserting the PICC is 90.8% material and 9.2% labor.

Source: Prepared by the authors.

Legend: CVPC: central venous port catheters; EUR: Euro; PICC: peripherally inserted central catheter; ECG: electrocardiogram; PORTOCATH: totally implanted chest port; US\$: American dollars.

DISCUSSION

In stage V (discussion), the studies showed that the major cost is related to materials, represented by the high cost of catheter kits (catheter/needle/angulators), as well as the labor (MoD) of professionals and the management of complications. All the studies analyzed were conducted in hospital institutions, with the involvement of nurses during nursing care.

All the studies address the need to measure personnel costs, which is done by calculating the MoD of the professional involved in the procedure, which is obtained from the procedure time and the average salary, a result that corroborates the literature, which calculates the MoD based on the time spent by the professional and their income⁽²⁰⁾.

Interventional implantation (outpatient/bedside level) is much more economical than surgical implantation (S1), confirming the findings of international studies^(21,26).

Studies S1, S2, S3, and S5 included the following equipment to obtain the costs:

ultrasound (US) for the guided technique, fluoroscopy/x-ray of the thorax, and intracavitary ECG tracking to confirm the tip.

Based on international evidence, US-guided insertions and the use of intracavitary ECG require less repositioning of the tip when compared to blind insertions and with confirmation by chest x-ray, in addition to reducing reinsertion and complication rates, US also allows visualization of deep veins, measurement and exact location of the vessel, proving to be a safer, more accurate and less expensive method^(4,21,22). Study S2 was consistent with the aforementioned data.

Two studies (S1 and S5) considered the calculation of equipment depreciation. An international study demonstrated the importance of properly managing the maintenance of hospital equipment, since preventive maintenance extends the useful life of the equipment and reduces hospital costs⁽²³⁾.

All the studies included materials, medicines, and solutions in their calculations. However, S4, S5, and S6 highlighted catheter kits as the items with the most representative values for the

composition of costs. A national study confirms this finding and shows that puncture kits have the most significant value in this category, followed by the unit cost of catheters⁽²⁴⁾.

A great variation was found in the costs described in the studies, with the lowest cost being US\$215.68 (S2) and the highest US\$881.81 (S5).

Studies S3 and S5 presented complications as a factor generating variable costs and their relation to total costs. Studies cite the importance of training teams in the correct management of PICCs and the choice of appropriate treatment in order to reduce complications and, consequently, minimize costs to institutions^(25,4).

Study 5 analyzed the reasons for non-elective removals and cited obstruction and catheter-related bloodstream infection (CRBSI) as the most common issues responsible for increasing PICC-related complications. Studies corroborate this result and point to obstruction, infiltration, phlebitis, and sepsis/infection as the most prevalent reasons and as generating variable costs^(22,25,26).

The use of PICCs with assertive indications for patients with prolonged hospitalizations in IVT, difficult venous access, or using medications with the potential to cause sclerosis of the vessels, can reduce hospital costs, since it favors the minimization of complications and therefore the reduction of associated costs⁽²⁷⁾.

CONCLUSION

Including cost data in PICC studies may qualify decision-making and be an important management tool for nurses.

The evidence of this review study showed the relevance of including, in cost calculations, data on the consumption of materials, medicines, solutions, MoD of the professional involved in the care of the patient using PICC, equipment, and management of complications. The bedside technique proved to be more economical. The US-guided technique, when compared to blind direct puncture insertion, also showed lower costs. The total cost cited in the studies ranged from US\$215.68 to US\$881.81.

Knowing the costs associated with nursing care in the use of PICCs, i.e. in the implantation, maintenance, handling, and removal of PICCs can contribute to optimizing inputs, controlling waste, minimizing the costs generated for institutions, and improving the quality of care.

This study's results can hopefully be used by health institution managers to help incorporate technologies and guide clinical protocols that include cost monitoring.

The different items associated with PICC costs described by the studies proved to be a limiting factor in the comparative analysis of the main results obtained, given the wide variation in total costs.

CATETER CENTRAL DE INSERÇÃO PERIFÉRICA E CUSTOS ASSOCIADOS À ASSISTÊNCIA DE ENFERMAGEM: REVISÃO INTEGRATIVA

RESUMO

Objetivo: Analisar a produção científica sobre os custos associados ao uso do cateter central de inserção periférica na assistência de enfermagem à pacientes hospitalizados. **Método:** Revisão integrativa em que a estratégia de busca foi elaborada por meio da estratégia PICO, um total de 688 artigos, inicialmente, foram encontrados, após leitura de título e resumo, restaram 11 artigos para leitura na íntegra, destes, seis foram incluídos na revisão. **Resultados:** As evidências deste estudo apontaram ser importante incluir nos cálculos de custos, os dados de consumo de materiais, mão de obra, medicamentos, soluções, manutenção do cateter, manejo das complicações e ainda os custos com depreciação dos equipamentos utilizados durante a inserção. O uso das tecnologias durante a assistência de enfermagem reduz os custos associados. A utilização do ultrassom durante a implantação do cateter apresentou menores custos em relação à implantação às cegas, devido a menor incidência de complicações. A técnica beira-leito mostrou-se mais econômica. Quanto ao custo total citado nos estudos, houve uma variação de US\$215,68 a US\$881,81. **Conclusão:** Conhecer os custos associados à assistência de enfermagem ao cateter central de inserção periférica em pacientes hospitalizados pode contribuir para a otimização dos insumos, minimização dos custos gerados às instituições e para a melhoria da qualidade assistencial.

Palavras-chave: Assistência de Enfermagem. Cateterismo Periférico. Dispositivos de Acesso Vascular. Custos e Análise de Custo. Custos Diretos de Serviços.

CATÉTER CENTRAL DE INSERCIÓN PERIFÉRICA Y COSTES ASOCIADOS A LA ASISTENCIA DE ENFERMERÍA: REVISIÓN INTEGRADORA

RESUMEN

Objetivo: analizar la producción científica sobre los costes asociados al uso del catéter central de inserción periférica en la asistencia de enfermería a pacientes hospitalizados. **Método:** revisión integradora en que la estrategia de búsqueda fue elaborada por medio de la estrategia PICO, un total de 688 artículos, inicialmente, fueron encontrados, tras la lectura del título y resumen, restaron 11 artículos para lectura en su totalidad, de estos, seis fueron incluidos en la revisión. **Resultados:** las evidencias de este estudio señalaron la importancia de incluir en los cálculos de costes, los datos de consumo de materiales, mano de obra, medicamentos, soluciones, mantenimiento del catéter, manejo de las complicaciones y también los costes con depreciación de los equipos utilizados durante la inserción. El uso de las tecnologías durante la asistencia de enfermería reduce los costes asociados. La utilización del ultrasonido durante la implantación del catéter presentó menores costes con relación a la implantación a ciegas, debido a la menor incidencia de complicaciones. La técnica *Beira-Leito* se mostró más económica. En cuanto al coste total citado en los estudios, hubo una variación de US\$215,68 a US\$881,81. **Conclusión:** conocer los costes asociados a la asistencia de enfermería al catéter central de inserción periférica en pacientes hospitalizados puede contribuir para la optimización de los insumos, minimización de los costes generados a las instituciones y para la mejora de la calidad asistencial.

Palabras clave: Asistencia de Enfermería. Cateterismo Periférico. Dispositivos de Acceso Vascular. Costes y Análisis de Coste. Costes Directos de Servicios.

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