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# Phlebitis Incidence Associated to Peripherally Inserted Central Catheters in Adults ICU: Implementation of a Nursing Protocol

Incidencia de Flebitis asociada a Catéteres Centrales de Inserción Periférica en UCI Adultos: Implementación de un Protocolo para Enfermería

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## ABSTRACT

Phlebitis incidence related to peripherally inserted central catheters (PICCs): New nursing protocol application. Phlebitis is one of the most common complications of peripherally inserted central catheters (PICCs). The scientific evidence about the utility of measuring scales to phlebitis diagnosis is very limited.

**Objectives**: To compare phlebitis incidence rate before and after the introduction of a new protocol.

**Materials and Methods**: Retrospective cohort study in 159 patients admitted to the intensive care unit (ICU) for two years. First we assess phlebitis in 59 patients (group 1). After that we apply a new protocol to identify phlebitis with visual score and continuous evaluation to 100 patients (group 2)

**Results**: The probability of being diagnosed of phlebitis is significantly smaller in intervention group (OR: 0.09; 95% C.I.: 0.02-0.57).

**Conclusions**: Protocol application reduced the diagnosis of phlebitis in 90%

**Keywords:** Peripherally inserted central catheters (PICCs,) Phlebitis, Visual Infusion Phlebitis Score, Protocol, ICU.

## RESUMEN

**Justificación**: La flebitis es una de las complicaciones mas frecuentes de los Catéteres Centrales de Inserción Periférica. La evidencia científica sobre la utilidad de las escalas de medición para el diagnostico de flebitis es escasa.

**Objetivos**: Comparar la incidencia de flebitis antes y después de la implementación de un protocolo.

**Material y métodos**: Estudio de cohortes retrospectivo en 159 pacientes ingresados en UCI, a los que se les ha colocado un PICC, en dos periodos equivalentes de dos años consecutivos, Periodo 1 (n=59); frente a un grupo del Periodo 2 (n=100) en el que se aplicó un nuevo protocolo para el diagnóstico y manejo de flebitis (definición de flebitis, aplicación de la Visual Infusion Phlebitis Score y valoración continua).

**Resultados**: El riesgo de ser diagnosticado de flebitis fue significativamente menor en el P2 (OR: 0.09, I.C.95% 0.01-0.52)

**Conclusiones**: La incorporación del protocolo redujo un 90% los diagnósticos de flebitis.

**Palabras clave:** Catéter Central de Inserción Periférica; Flebitis: Visual Infusion Phlebitis Score; Protocolo; UCI

## INTRODUCTION

Central Venous Catheters (CVCs) are a core part of critical patient care[1]. Either CVCs or peripherally inserted central catheter (PICCs) are needed to supply multiple therapeutical agents through an intravenous access that can be used for a prolonged period of time. Some of them, such as chemotherapy, parenteral nutrition and hypertonic saline only can be safely delivered through central venous system[2]. CVCs and PICCs also are needed to monitorial and continuous blood sample extractions[3, 4], which are frequent in intensive care units (ICUs).

PICCs popularity is increasing because of their many advantages compared to CVCs. For instance, PICCs are easier to set up[5], they cause less pain in insertion area[6] and their extraction has lesser risks. Thus, they are a safe and effective alternative to CVCs[8]. Moreover, PICCs have lesser catheter-related bloodstream infections rates and they are more comfortable for the patients[6,9], minimizing by this way other CVCs-related complications, such as hemothorax and pneumothorax[10,11].

Despite their advantages, PICCs have risks of complications like bad positioning of catheter, thrombosis, phlebitis, hemorrhage, arrhythmia, bacteremia, nerve and tendons damage and chest pain[6,7]. Of all of them, phlebitis is one of the most frequent complications[7]. Phlebitis risk seems to be reduced when polyurethane PICCs are used instead of silicone ones[12]. In the same way, Seldinger's modified catheter arterial catheterization reduces tissue trauma and the probability of using more than one needle, lowering complications rates[13]. Moreover, catheter lumen and insertion area[2] are risk factors of PICCs-related phlebitis, without being affected by the therapeutical agents infused.

In ICUs, multilumen catheters are frequently used, and their higher lumen is associated with phlebits[2].

Several studies have showed the effectivity of PICCs insertion protocols, managed by nurse specialists, in reduction of PICCs complication[14]. However, there is little evidence about the diagnosis of PICCs-related phlebitis in ICUs patients. In 2014, a

systematic review showed that there are a lot of phlebitis scales, but none of them had been validated to use in clinical settings[15]. This is an important issue, because depending on the scale used, the phlebitis incidence varies considerably[2]. The Visual Infusion Phebitis (VIP) Score[16] is one scale usually used in diagnosis and care of phlebitis in pheriferic venous catheters, but there is no evidence of its use in patients with PICCs.

Phlebitis can be mechanical or infectious origin. The incidence of infectious phlebitis has decreased dramatically with implementation of bacteremia Zero Protocols[17]. Mechanical phlebitis begins with any vein trauma, such a catheter insertion, causing endothelial changes with activation of complement, coagulation and fibrinolysis systems. The blood flow decrease and inflammatory response causes hypersensibility and erythema in the catheter insertion, but it can evolve towards infectious or thrombotic complications, increasing patient hospitalization days, their healthcare costs, and the patient discomfort regarding to the withdrawal and reinsertion of a new catheter[2]. Therefore, the development of interventions that reduce this problem constitutes a need for nursing professionals.

The present study has the following objectives:

1. To Compare the incidence of phlebitis before and after the implementation of a new standardized protocol that includes the scale VIP as phlebitis diagnostic tool in two different periods: period 1 (P1): October 2012-February 2013 and period 2 (P2): October 2013-February 2014.
2. To know the incidence of PICC-related phlebitis and to analyze the risk factors related to their development in ICU patients hospitalized in the ICU of Complejo Hospitalario de Navarra (CHNa).
3. To compare the incidence of phlebitis of two-lumen catheters versus three-lumen ones.

## METHOD

The study was conducted in a polyvalent ICU of 12 beds in CHNa, whose reference specialties includes plastic surgery, maxillofacial surgery and Gynecology. The cause of major percentage of patient incomes is medical pathologies (55%). The ICU is composed by 10 open boxes longitudinally disposed, and 2 closed ones for insulation.
A protocol to observe, diagnose and manage phlebitis was defined, and the staff nurses of the ICU were trained about it. This Protocol consisted of:

1. Phlebitis diagnostic criteria of The VIP Score (1998)[16].

2. Assessment and monitoring criteria for the point of PICC insertion for each staff turn.

3. In those cases with 2 points VIP Score scale, hygiene and surveillance measures were applied to see if inflammation was healing or evolving to phlebitis (3 or more points on the scale), in which case the catheter was withdrawn (see table 1).

**Table 1**: Score for the detección and treatment of the phlebitis

| Number | Sign | **Meaning and procedure** | **Changes for this review** |
|---|---|---|---|
| 0 | There aren´t pain or erythema. | Observe puncture´s place. | |
| 1 | Pain /erythema around the catheter insertion place. | The first signs of phlebitis appear.<br>Observe catheter insertion place. | |
| 2 | We observe two of these signs: erythema, pain on the vain or inflammation. | There are signs of phlebitis.<br>Replace the catheter. | Possible signs of phlebitis.<br>Local warm.<br>Raise the extremity.<br>Continuous evaluation. |
| 3 | We observe pain on the vain, erythema and inflammation. | Established phlebitis.<br>Replace the catheter and consider start the treatment. | |
| 4 | We observe pain on the vain, erythema and hardening and palpable vain. | Continuing phlebitis and/or start the thrombosis.<br>Replace the catheter and consider start the treatment. | |
| 5 | We observe vain pain, hardening, palpable vain and fever. | Advanced thrombosis.<br>Replace the catheter.<br>Start the treatment. | |

Adapted from Jackson A. (1998)

To assess the incidence of phlebitis before and after Protocol incorporation, a retrospective cohort study was conducted within two groups of patients admitted in equivalent periods of two consecutive years: period 1 (P1), from October to February 2012/2013; and Period 2 (P2), from October to February 2013/2014.

Data was collected through the nurses' registries documents and the computerized medical records from the CHNa. Patients who had carried one of more PICCs during these periods were selected.

In both periods, all PICCs were inserted by nurses using Seldinger's technique. Polyurethane catheters were used and recommended standard precautions of the bacteremia Zero project were followed[17]. Target vein was chosen by the nurse according to familiarity and confidence to perform the PICC insertion. Catheter location was confirmed by chest x-ray. The type of catheter and its number of lumen was decided according to its therapeutic goal. For the PICCs surveillance, Bacteremia Zero project-based hospital nursing protocols[17] were followed.

To diagnose phlebitis, periodic observations were carried out by three nurses, unifying criteria according to the current protocol to reduce results variability. Study variables

and PICCs insertion point was registered on a nursing graph, which were daily reviewed.

Studied variables were: age, sex, criteria patient severity criteria according to APACHE II[18], channeled vein (basilic vs cephalic), number of lumen(two vs. three lumen), date of PICC insertion and withdrawal, number of days with PICC inserted, date of discharge and presence of PICC-related phlebitis (yes vs no). We considered cases of phlebitis those patients who had 3 or more points in VIP Score scale. In addition, in those cases with a score of 2 points on the scale (two of the three signs: pain, erythema, and swelling), nursing interventions were aimed monitoring the patient by staff turns to prevent or monitor the progression to phlebitis.

To perform the planning and evaluation of this activity in the service, since it is within the hospital safety plan, ICU responsible was asked for permission, and we received his written approval. Patient data were managed confidentiality. Also, the study received the approval from the CHNa research service.

To perform data analysis, STATA 12 statistical package was used. Statistical signification for p values were established at $\alpha = 0.05$ (two tails test).

Categorical variables were expressed through frequencies distribution. Continuous variables were described with means and standard deviations.

Differences in variables distribution between study periods were assessed by performing univariate analysis. Chi-square test was used for categorical variables and a means comparison Student's T-test for quantitative variables.

Also, to assess the interaction between the incidence phlebitis incidence and the study variables according to study period, a multivariate logistics regression model was performed stratifying by study period and adjusting by sex, age, and those variables that showed a statistically significant association in the univariate model.

Finally, to find the association between phlebitis and number of catheters lumens, a Chi-square test was used in both periods.

## RESULTS

During P1 and P2, 59 and 100 patient data were collected respectively.

The qualitative and quantitative variables distribution is shown in table 2.

**Table 2**: Variable distribution in our sample

| Variable | Category | Period 1 | Period 2 | Total | P value |
|---|---|---|---|---|---|
| **Gender** | **Male** | 38 (64.41) | 64 (64) | 102 (64.15) | 0.959 |
| | **Female** | 21 (35.59) | 36 (36) | 57 (35.85) | |
| Age | 17-52 | 9 (15.25) | 32 (32) | 41 (25.79) | 0.055 |
| | 53-63 | 21 (35.59) | 20 (20) | 41 (25.79) | |
| | 66-76 | 15 (25.42) | 26 (26) | 41 (25.79) | |
| | 77-91 | 14 (23.73) | 22 (22) | 36 (22.64) | |
| Catheter type | 2 ways | 45 (76.27) | 54 (54) | 99 (62.26) | 0.005 |
| | **3 ways** | 14 (23.73) | 46 (46) | 60 (37.74) | |
| APACHE II (%) | 1-11 | 17 (28.81) | 35 (35) | 52 (32.7) | 0.366 |
| | 12-16 | 10 (16.95) | 22 (22) | 32 (20.13) | |
| | 17-23 | 13 (22.03) | 23 (23) | 36 (22.64) | |
| | 24-38 | 19 (32.2) | 20 (20) | 39 (24.53) | |
| **Phebitis** | No | 50 (84.75) | 98 (98) | 148 (93.08) | <0.001 |
| | **Yes** | 9 (15.25) | 2 (2) | 11 (6.91) | |
| Age (standard deviation) | | 64.6 (13.99) | 61.57 (17.72) | 62.51 (16.47) | 0.217 |
| APACHE II (s d) | | 18.27 (9.13) | 16.71 (8.13) | 17.29 (17.29) | 0.265 |
| catheter's duration (s d) | | 6.59 (6.0) | 7.41 (6.55) | 7.11 (6.38) | 0.474 |

Phlebitis incidence was statistically different among the two periods accordant to catheters. Age variable was at the limit of statistical significance.

P1 Participants (n = 59) presented the following demographic variables distribution: 38 (64,41%) were men and 21 (35,58%) women and the age was comprised between 32 and 87 years with an average of 64.60; patients severity according to the APACHE II scored from 3 to 45; 76.27% (45) of inserted catheters were 2-lights catheters and 23.73% (14) were 3-light ones; average catheter insertion duration was 6.59 days and during this period 9 cases of phlebitis (15.25%) were diagnosed.

P2 participants (n = 100) variables distribution was the following: 64% were men and 36% women; age ranged between 17 and 90 years with an average of 61.57; patients severity according to the APACHE II scored from 1 to 38; of the 100 inserted PICC, 54% of inserted catheters were 2-lights ones and 46% were three lights catheters; average catheter insertion duration was 7.41 days and during this period there was 2 patients diagnosed of phlebitis (2%) were performed. These data, both P1 and P2, are shown in table 2.

Table 3 shows the study variables Odds Ratios stratified by periods.

**Table 3**. Association between phlebitis and variables in both periods

| | Phlebitis | | | | | |
|---|---|---|---|---|---|---|
| | P Chi$^2$ | | Odds Ratio | | P value (95% C.I) | |
| Variable | Period 1 | Period 2 | Period 1 | Period 2 | Period 1 | Period 2 |
| Gender (1) | 0.363 | 0.284 | 1.70 | ---- | 0.371 (0.26-11.25) | ---- |
| **Age (2)** | 0.377 | 0.551 | 0.95 | 0.96 | 0.359 (0.88-1.02) | 0.398 (0.84-1.04) |
| Catheter type (3) | 0.113 | 0.909 | 2.46 | 0.96 | 0.125 (0.38-16.01) | 0.909 (0.05-19.93) |
| APACHE II(4) | 0.006 | 0.651 | 2.90 | 0.99 | 0.022 (1.80-7.13) | 0.024 (0.30-3.08) |

(1) Male above female. (2) Quantitative (ages). (3) 3 ways catheter above 2 ways catheter. (4) Apache scale in quartiles.

We found no statistically significant differences in variables Odds Ratios according to period. APACHE and catheter type Odds Ratio considerably varied from one period to another, however, these differences was not statistically significant.

During the P2, a low phlebitis incidence was observed (2%), compared to P1 (15.25%).

We didn´t found statistically significant differences of phlebitis incidence according to type of catheter in both P1 (p=0.424) and P2 (p = 0.602).

Table 4 shows the study variables Odds Ratio adjusted by period.

**Table 4.** Association between phlebitis and the variables of this review adjusted by periods

| Variable | OR | P value | **95% Confidence Interval** |
|---|---|---|---|
| Gender (1) | 2.66 | 0.262 | 0.48-14.60 |
| **Age (2)** | 0.96 | 0.081 | 0.91-1.01 |
| **Catheter type (3)** | 1.73 | 0.479 | 0.38-7.86 |
| APACHE II (4) | 1.99 | 0.035 | 1.05-3.80 |
| Study period (5) | 0.09 | 0.007 | 0.01-0.52 |

(1) Male above female. (2): Quantitative (ages). (3): 3 lumens catheter above 2 lumens catheter. (4): Apache scale in quartiles. (5): Period 2 vs Period 1.

Statistically significant differences in phlebitis incidence were found were found when comparing the periods 1 and 2 (p = 0.001), being the risk of being diagnosed with phlebitis was significantly lower in the P2 (OR: 0.09; 95% C.I.: 0.02-0.57) against the P1.

Phlebitis Odds Ratio associated to APACHE II scale or the type of catheter used varied in magnitude when stratified instead of adjusting by period, which suggests a possible interaction effect between the study period and the phlebitis incidence according to these variables.

No significant differences were found regarding other variables factors such as age, sex, and APACHE II phlebitis.

Finally, we found a statistically significant association between the patient severity (highest APACHE II score) and the three-lumen catheter insertion (p = 0.013).

## DISCUSSION

This is the first study that assesses the use of VIP Score scale for PICC management. PICC use in clinical practice is becoming very common in ICUs, due to its easy insertion and a low incidence of complications compared with CVC[7, 10, 11].
There are studies in literature which show PICCs are a safe and effective tool in ICU patients and they are an excellent option to drug and solutions delivery among extended periods of time[19].

This study provides some evidence of the usefulness of the VIP Score use in adult patients with PICC to detect and manage phlebitis accurately. We have not found conclusive evidence related to an increased phlebitis incidence in three-lumens catheters compared to the two-lumen ones.

A case-control study conducted by Mazzola et al[2] found an association between phlebitis risk and catheter caliber. In our study, the three-lumen and two-lumen catheters had a diameter of 2.4 mm and 2.3 mm respectively, so the absence of statistically significant differences could be explained because of scarcity of size differences between both types of catheters (only 0.1 mm)

Moreover, in our study, three-lumen catheters were more frequently inserted in patients with greater severity according to the APACHE II. One possible explanation is that

more severe patients would have needed more invasive treatment and monitoring[3], which could have favored the decision to use catheters with more lights. In addition, the severe status of these patients usually requires the use of more aggressive multiple drugs that may be risk factor for phlebitis[2].

On the other hand, there was a reduction of the phlebitis Odds Ratio according to used type of catheter used APACHE II scale score during the P2. That reduction could be explained by changes in hygiene and observation practices based on the new unit protocol. These measures could have been carried out with more effort in the most severe patients or in those with tree-lumen catheters, which could explain the possible interaction between these variables and the study period for phlebitis risk.

As for the diagnosis of phlebitis, our data show that there is a marked decline in phlebitis diagnosed cases after Protocol implementation in the P2. This reduction in the incidence of phlebitis may be due to several factors.

First, specific training received by nursing staff on the use of the VIP Score might have helped to aware professionals about risks of phlebitis, thus improving the techniques of catheter insertion, and changing the selection of catheter types during the second period. On the other hand, in this retrospective study data were collected on computerized medical records, so the data can be poorly classified, especially by a possible loss of information related to the variables of study in P1 before the observations measures implanted by the new Protocol. This fact can have biased our results towards the null hypothesis, because medical records may not have had data from all the possible phlebitis of P1. However, despite this limitation, we have found statistically significant differences between the two periods.

Second, we cannot exclude that the decrease in phlebitis incidence has been due to unknown factors present during and between study periods, despite having chosen two equivalents study periods in the calendar.

Third, our VIP Score scale modification, indicating not to remove catheters until it is obtained a score of 3 on the scale and instead to monitor and care catheters with a score of 2, may have caused a decrease of diagnoses of phlebitis by a change in the classification of them. We are not able to exclude that some diagnosed phlebitis in P1 could have had 2 points on the scale VIP Score. There are studies which describe that inflammatory signs and erythema at the insertion point are misleader symptoms which may be confused with phlebitis, especially in more superficial veins of smaller caliber. With a continued monitoring by nurses staff and proper treatment with heat and elevation, these signs can disappear without further complications[2].

We hypothesize that nurses training VIP Score scale manage and its subsequent implementation avoid potential over-diagnosis of phlebitis. This protocol can be useful in avoiding premature PICC withdrawal and subsequent catheter replacement, which could decrease the PICC-associated, healthcare costs and work pressure, with the improvement on quality and safety of care[20].

As a recommendation for future research, we think it would be convenient to validate the use of this scale in PICCs management.

## CONCLUSIONS

After protocol implantation, we observed a decrease in the phlebitis incidence between P1 and P2, and no statistically significant differences in other related factors.
Likewise, we have found no association between the incidence of phlebitis and type of catheter inserted.

The protocol implementation, which includes interventions such as the phlebitis definition, the VIP score management and the continue evaluation by nurses staff, greatly reduced the diagnosed cases of phlebitis. These differences can be explained by decrease of over-diagnosis. More studies are needed to explore these findings. The recent Phlebitis Zero project involves an opportunity to study in this type of catheters[21].

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