



## Research article

# The endoscopy department can alert to complications associated with peripheral venous catheters in patients admitted to a tertiary teaching hospital

María Jesús Pérez-Granda<sup>a,b,c,\*</sup>, Francisca Guzmán Blanco<sup>e</sup>, Sonia Aguado Díaz<sup>e</sup>, Rosario Jiménez Bautista<sup>e</sup>, Julia Orense Velilla<sup>e</sup>, Juana Rodríguez Calero<sup>e</sup>, María Luisa Valls<sup>e</sup>, Antonio Vicente Arellano<sup>e</sup>, Pilar García Santos<sup>e</sup>, Patricia Muñoz<sup>a,c,d,f,\*\*</sup>, María Guembe<sup>a,d</sup>, on behalf of the GEEN study group (Grupo de Estudio en Endoscopias)

<sup>a</sup> Department of Clinical Microbiology and Infectious Diseases, Hospital General Universitario Gregorio Marañón, Madrid, Spain

<sup>b</sup> Department of Nursing, School of Nursing, Physiotherapy and Podiatry, Universidad Complutense de Madrid, Madrid, Spain

<sup>c</sup> CIBER Enfermedades Respiratorias-CIBERES (CB06/06/0058), Madrid, Spain

<sup>d</sup> Instituto de Investigación Sanitaria Gregorio Marañón, Madrid, Spain

<sup>e</sup> Endoscopy Department, Hospital General Universitario Gregorio Marañón, Madrid, Spain

<sup>f</sup> Department of Medicine, Universidad Complutense de Madrid, Madrid, Spain

## ARTICLE INFO

## Keywords:

Peripheral venous catheter  
Endoscopy  
Emergency room  
Complications  
Surveillance  
Phlebitis  
Infection

## ABSTRACT

**Background:** The more widespread use of peripheral venous catheters (PVC) has led to more frequent complications, not only in PVC-associated bacteremia, but also in phlebitis. This requires the catheter to be removed and increases healthcare costs. Our aim was to assess the PVC-associated complications in an endoscopy department.

**Methods:** We performed a cross-sectional, descriptive study on patients admitted to our center and undergoing a procedure in the endoscopy department. We analyzed the appearance of the following PVC-associated complications: obstruction, phlebitis, redness, extravasation, pain, and infection on the day of the study. All catheter tips were sent to the microbiology laboratory for culture using the roll-plate semiquantitative technique. Clinical and microbiological data were collected.

**Results:** We included a total of 46 patients with 50 PVCs. The median (IQR) age was 70.0 (55.0–81.5) years, and 58.7% were female. The median (IQR) hospital stay was 9.00 (6.00–14.25) days. Of the 50 PVCs, most were inserted in the emergency room (74.0%), and the median (IQR) indwelling time was 5.00 (3.00–7.00) days. The phlebitis rate was 78.0%, which occurred mainly in PVCs inserted in the emergency room (74.3%). The tip was colonized in 9 PVCs (18.0%).

**Conclusion:** The endoscopy department can alert clinicians to PVC-associated complications. PVCs inserted in the emergency room were subject to a higher risk of phlebitis and/or colonization. Therefore, we recommend systematically replacing PVCs inserted in the emergency room within 48 h if preventive measures during insertion cannot be guaranteed.

\* Corresponding author. Servicio de Microbiología Clínica y Enfermedades Infecciosas, Hospital General Universitario Gregorio Marañón, C/ Dr. Esquerdo, 46, 28007, Madrid, Spain.

\*\* Corresponding author. Servicio de Microbiología Clínica y Enfermedades Infecciosas Hospital General Universitario Gregorio Marañón C/ Dr. Esquerdo, 46 28007, Madrid, Spain.

E-mail addresses: [massus@hotmail.es](mailto:massus@hotmail.es) (M.J. Pérez-Granda), [pmunoz@hggm.es](mailto:pmunoz@hggm.es) (P. Muñoz).

<https://doi.org/10.1016/j.heliyon.2024.e35082>

Received 13 February 2024; Received in revised form 2 July 2024; Accepted 22 July 2024

Available online 3 August 2024

2405-8440/© 2024 Published by Elsevier Ltd.

This is an open access article under the CC BY-NC-ND license

(<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## 1. Introduction

Intravascular catheters are essential for appropriate patient management. However, indwelling time is directly related to the risk of complications [1,2]. A meta-analysis of 76,977 peripheral venous catheters (PVCs) revealed an unacceptable rate of complications, with phlebitis being the most frequent [3].

Catheter colonization is also a major PVC-associated complication. It is caused directly by manipulation itself and occurs before the appearance of catheter-related bloodstream infection (C-RBSI), whose morbidity and mortality rates and costs are high [4,5]. While the risk of PVC-related bloodstream infection (PVC-RBSI) in patients admitted to medical wards may seem low, related complications are severe and associated with high mortality rates [6].

In a multicenter study on the use of endovascular catheters in internal medicine departments in Spain ("NUVE" Project), not only did the authors record an increase in the incidence of PVC-RBSI (from 0.11 to 0.18 episodes/1000 admissions in 2007 to 1.64 episodes/1000 admissions in 2017), but they also detected phlebitis in 62.9% of cases. Moreover, they demonstrated that the risk of developing phlebitis was 5 times higher when the PVC was inserted in the emergency room [7].

In clinical practice, the PVC tip is not always sent for culture, even though guidelines recommend culturing any vascular catheter in which infection is suspected [8,9]. Therefore, the rate of phlebitis and/or colonization is underestimated. Our objective was to determine phlebitis and colonization rates among patients with PVCs admitted to a tertiary teaching hospital on the day they underwent a procedure in the endoscopy department.

## 2. Material and methods

The hospital has approximately 1550 beds and attends a catchment population of 750,000 inhabitants. Approximately 20,000 procedures per year are performed in the endoscopy department.

### 2.1. Endpoints of the study

The primary endpoint was to assess the PVC-associated complications in an endoscopy department.

### 2.2. Study design

We performed a cross-sectional, descriptive study on patients admitted to our center and undergoing a procedure in the endoscopy department. We analyzed the appearance of the catheter on the day of the study. Data were collected from 50 patients between November 2022 and March 2022 (5 months). A visual assessment scale for phlebitis was used to measure complications related to PVCs. The visual scale consisted of the presence of the following clinical signs: phlebitis (warmth, tenderness, erythema and palpable venous cord), catheter malfunction, extravasation, reflux through the insertion point, signs of local irritation, suspected infection and/or venous thrombosis.

All healthcare workers from the endoscopy department were informed of the content of the study. Data were collected by endoscopy nurses with experience in PVC management. The coordinator informed them about the study protocol and the data collection forms.

Patients were monitored until catheter withdrawal. If the PVC showed any complication (pain, extravasation, redness, or phlebitis), the catheter tip was removed and sent to the microbiology laboratory for culture using the semiquantitative roll-plate technique (Maki). When PVC-RBSI was suspected, 3 sets of blood cultures were obtained.

### 2.3. Definitions

- Catheter colonization: isolation of a microorganism(s) in a significant count ( $\geq 15$  cfu/pate) [9].
- Phlebitis: presence of redness, swelling, tenderness, and/or inflammation.
- Peripheral-line associated bloodstream infection (P-LABSI): P-LABSI is defined based on the guidelines for the diagnosis and management of catheter-related infections, that is, the patient must be febrile with an indwelling PVC (at least 48 h) and no other possible source of infection [9].
- PVC-RBSI: PVC-RBSI requires microbiological confirmation of the catheter as the source of the bloodstream infection (same microorganism[s] in catheter culture and in peripheral blood cultures) [9].

### 2.4. Statistical and clinical analysis

Qualitative variables appear with their frequency of distribution. Quantitative variables are expressed as the mean and standard deviation (SD) and, in the case of a non-normal distribution, as the median and interquartile range (IQR). Continuous variables were compared using the *t*-test in the case of a normal distribution and the median test in the case of a non-normal distribution. The chi-squared or Fisher exact test was used to compare categorical variables. We compared whether there was an association between catheter use and insertion site/area with complications associated with these catheters.

Statistical significance was set at  $p < 0.05$  for all the tests. The statistical analysis was performed using IBM SPSS Statistics for

Windows, Version 21.0 (IBM Corp, Armonk, New York, USA).

We have not calculated the sample size because we did not know the rate of complications associated with PVCs in this department.

### 3. Results

Over the 5-month study period, 780 endoscopic procedures were performed in patients admitted to the hospital. In 46 patients (5.9 %), it was necessary to remove the catheter mainly because of phlebitis or obstruction. Finally, a total of 50 PVCs were withdrawn and included in the study. Median (IQR) age was 70.0 (55.0–81.5) years, and 58.7 % of patients were female. The median (IQR) hospital stay was 9.00 (6.00–14.25) days. The underlying conditions of the patients were diabetes (28.3 %), followed by malignancy (15.2 %) and peptic ulcer disease (15.2 %) (Table 1).

Most of the 50 PVCs were inserted in the emergency room (74.0 %). The site of insertion was the forearm in 32.0 %, hand in 38.0 %, and skin fold in 30.0 % (Table 2). Median (IQR) catheter indwelling time was 5.0 (3.0–7.0) days, and 40.0% were placed to administer antibiotics (Table 2). Nine catheters (18.0 %) were colonized by the following microorganisms: *S. epidermidis*, 5 (55.6 %); coagulase-negative staphylococci, 2 (22.2 %); *Candida parapsilosis*, 1 (11.1 %); and *Corynebacterium* spp., 1 (11.1 %). At withdrawal, the clinical manifestations were phlebitis (78.0 %), redness (86.0 %), and pain (76.0 %) (Table 2).

Of the 37 catheters inserted in the emergency room, 29 (78.4 %) were complicated by phlebitis ( $p = 0.706$ ), and of the 9 colonized PVCs, 6 (66.7 %) were inserted in the emergency room ( $p = 0.840$ ). When we compared PVCs complicated by phlebitis or colonization, we found no statistically significant differences for the insertion site or catheter use.

### 4. Discussion

The aim of our study was to determine the potential risk of PCV-associated complications through detection in an endoscopy department. Our results indicate that it is necessary to reinforce catheter surveillance. In addition, they support findings reported by other authors, namely, that PVCs inserted in the emergency room carry a higher risk of removal for different reasons [7,10,11]. In our study, 78.4 % of the catheters inserted in emergency room showed phlebitis and 66.7 % were colonized.

The lack of adherence and compliance with recommendations during catheter insertion and care are also important: many catheters are removed in daily clinical practice owing to poor care. Alexandrou et al. found that many PVCs were placed in skin folds, were symptomatic or idle, had suboptimal dressings, or lacked adequate documentation [12].

One of the potential causes of PVC failure in our study was the type of substance administered through the PVC, as it has been demonstrated that some antimicrobials can lead to failure (40.0% in our study) [13].

Regarding the implementation of catheter bundles for insertion care and maintenance, there is no consensus on the most effective strategy for reducing complications associated with management of these devices [14,15]. Despite following national guideline recommendations for the prevention of PVC complications (daily vigilance, skin disinfection with alcoholic chlorhexidine 2%, disinfection of the connector before use, transparent dressing change every 7 days, administration set change every 7 days, and use of split septum connectors), we found that these measures were insufficient to reduce PVC complication rates at our centre. Such recommendations have proven successful elsewhere [15–17].

We also demonstrate that daily PVC monitoring was not sufficient to reduce the frequency of catheter withdrawal, although continuous surveillance programs are recommended to improve patient care and guarantee safety [18]. A recent study carried out in Portugal highlighted the need to monitor the catheter during each nursing shift for purposes of maintenance [19].

Finally, although guidelines recommend tip culture of all PVCs suspected of being infected [9], the number of catheters sent for culture remains low. This may explain the reduced frequency we report for phlebitis and colonization, which was considerably below real-world rates.

The novelty of our study is that we showed the endoscopy department to be a suitable, easy, and simple means of alerting to PVC-related complications. Catheter surveillance is a habitual practice in various hospitalization areas. According to our results, diagnostic testing services that require the manipulation of a catheter should remove catheters with suspected infection and send them for culture; hence the importance of improving the training of healthcare professionals in both diagnosis of catheter-related complications and catheter care. This training should be provided at the university level and in both hospitals and health centers where catheters are manipulated. PVC-associated complications are somewhat underestimated, perhaps because we attribute them less importance than they deserve. It is necessary to establish audits in order to implement checklists to evaluate PVC care.

Despite the limitations of our findings, such as the small sample size and the fact that it was carried out in a single institution, our study can help to change clinical practice. We suggest establishing a checklist to be used on each nursing shift to verify and monitor appearance of PVC-related complications before performing an endoscopic procedure. We also consider that more efforts are needed to ensure aseptic PVC insertion in emergency departments.

### 5. Conclusion

When PVCs are monitored, even in a non-hospitalization department, the associated complication rate is high. We believe it is necessary to monitor PVCs on every shift and before performing any procedure.

**Table 1**  
Characteristics of the patients.

Variable	Total, N = 46
<b>Patient sex, N (%)</b>	
Male	19 (41.3)
Female	27 (58.7)
<b>Median (IQR) age, years</b>	70.0 (55.0–81.5)
<b>Underlying condition, N (%)</b>	
Myocardial infarction	1 (2.2)
Central nervous system disease	5 (10.9)
Chronic obstructive pulmonary disease	4 (8.7)
Renal dysfunction	6 (13.0)
Diabetes mellitus	13 (28.3)
Peptic ulcer disease	7 (15.2)
Peripheral vascular disease	5 (10.9)
Malignancy	7 (15.2)
<b>Mortality, N (%)</b>	2 (4.3)

IQR, interquartile range.

**Table 2**  
Characteristics of the catheters of the study.

Characteristic	Total, N = 50
<b>Insertion Place, N (%)</b>	
Emergency Department	37 (74.0)
<b>Location, N (%)</b>	
Hand	19 (38.0)
Forearm	16 (32.0)
Flexure	15 (30.0)
<b>Size catheter (G), N (%)</b>	
20	29 (58.0)
22	20 (40.0)
18	1 (2.0)
<b>Use of catheter, N (%):</b>	
Fluid	8 (16.0)
Antibiotics	18 (36.0)
Medication	13 (26.0)
Others	1 (2.0)
<b>Reasons for catheter withdrawal, N (%)</b>	
Obstruction	31 (62.0)
Phlebitis	39 (78.0)
Redness	43 (86.0)
Extravasation	2 (4.0)
Pain	38 (76.0)
<b>Median (IQR) catheter indwelling time, days</b>	5 (3–7)
<b>Catheter tip colonization, N (%)</b>	9 (18.0)
<b>PVC-RBSI, N (%)</b>	0 (0.0)

IQR, interquartile range; PVC-RBSI, peripheral venous catheter-related bloodstream infection.

## Funding source

M. Guembe is supported by the Miguel Servet Program (ISCIII-MICINN, MS18/00008) from the Health Research Fund (FIS) of the Carlos III Health Institute (ISCIII), Madrid, Spain. The study was partially financed by grants from the ISCIII (PI21/00344), by the European Regional Development Fund (FEDER) “A way of making Europe”, and by the Fundación MUTUA Madrileña (FMM21/01).

## Consent for publication

Not applicable.

## Ethics statement

The study was approved by our Local Ethics Committee (MICRO.HGUGM.2022-022), which waived the need for informed consent, as data were collected only from the clinical records and catheter tip culture was performed only when there was suspicion of infection. This is standard practice at our institution.

## Data availability statement

Data sharing is not applicable to this article, as no datasets were generated or analyzed during the study.

## CRediT authorship contribution statement

**María Jesús Pérez-Granda:** Writing – review & editing, Writing – original draft, Validation, Supervision, Formal analysis, Data curation, Conceptualization. **Francisca Guzmán Blanco:** Formal analysis, Data curation. **Sonia Aguado Díaz:** Formal analysis, Data curation. **Rosario Jiménez Bautista:** Formal analysis, Data curation. **Julia Orense Velilla:** Formal analysis, Data curation. **Juana Rodríguez Calero:** Formal analysis, Data curation. **María Luisa Valls:** Formal analysis, Data curation. **Antonio Vicente Arellano:** Formal analysis, Data curation. **Pilar García Santos:** Formal analysis, Data curation. **Patricia Muñoz:** Writing – review & editing, Writing – original draft. **María Guembe:** Writing – review & editing, Writing – original draft, Funding acquisition, Conceptualization, GEEN study group (Grupo de Estudio en Endoscopias): Juliana Aguilar Vales, Beatriz Martínez Lobo, José Carlos Sanchez de la Torre, María Antonia Soto Gonzalez, Rocío Barragán Lagar, Helena Gil de Vicente, María Amor Gámez, Isabel Sigüenza Atienza, Pilar Martín Nieto and Angeles Soto González: Data curation.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Acknowledgements

We thank Thomas O'Boyle for his help in the preparation of the manuscript.

We thank the members of the GEEN study group.

Francisco Jesús Carrascosa Tamayo, Juliana Aguilar Vales, Beatriz Martínez Lobo, José Carlos Sánchez de la Torre, María Antonia Soto González, Rocío Barragán Lagar, Helena Gil de Vicente, María Amor Gámez, Isabel Sigüenza Atienza, Pilar Martín Nieto, Ángeles Soto González.

## References

- [1] M.J. Pérez-Granda, et al., A prevalence survey of intravascular catheter use in a general hospital, *J. Vasc. Access* 15 (6) (2014) 524–528.
- [2] L.A. Mermel, Short-term peripheral venous catheter-related bloodstream infections: a systematic review, *Clin. Infect. Dis.* 65 (10) (2017) 1757–1762.
- [3] N. Marsh, et al., Peripheral intravenous catheter non-infectious complications in adults: a systematic review and meta-analysis, *J. Adv. Nurs.* 76 (12) (2020) 3346–3362.
- [4] V.D. Rosenthal, et al., Six-year study on peripheral venous catheter-associated BSI rates in 262 ICUs in eight countries of South-East Asia: international Nosocomial Infection Control Consortium findings, *J. Vasc. Access* 22 (1) (2021) 34–41.
- [5] C. Liu, et al., Incidence, risk factors and medical cost of peripheral intravenous catheter-related complications in hospitalised adult patients, *J. Vasc. Access* 23 (1) (2022) 57–66.
- [6] B. Drugeon, et al., Incidence, complications, and costs of peripheral venous catheter-related bacteraemia: a retrospective, single-centre study, *J. Hosp. Infect.* 135 (2023) 67–73.
- [7] M. Guembe, et al., Nationwide study on peripheral-venous-catheter-associated-bloodstream infections in internal medicine departments, *J. Hosp. Infect.* 97 (3) (2017) 260–266.
- [8] F.A. Manian, IDSA guidelines for the diagnosis and management of intravascular catheter-related bloodstream infection, *Clin. Infect. Dis.* 49 (11) (2009) 1770–1771, author reply 1771–1772.
- [9] F. Chaves, et al., Executive summary: diagnosis and treatment of catheter-related bloodstream infection: clinical guidelines of the Spanish society of clinical microbiology and infectious diseases (SEIMC) and the Spanish society of intensive care medicine and coronary units (SEMICYUC), *Enferm. Infecc. Microbiol. Clín.* 36 (2) (2018) 112–119.
- [10] B. Guihard, et al., Appropriateness and complications of peripheral venous catheters placed in an emergency department, *J. Emerg. Med.* 54 (3) (2018) 281–286.
- [11] R. Morgan, et al., From little things, big things grow: an exploratory analysis of the national cost of peripheral intravenous catheter insertion in Australian adult emergency care, *Emerg. Med. Australasia (EMA)* 34 (6) (2022) 877–883.
- [12] E. Alexandrou, et al., Use of short peripheral intravenous catheters: characteristics, management, and outcomes Worldwide, *J. Hosp. Med.* 13 (5) (2018).
- [13] N. Marsh, et al., Peripheral intravenous catheter failure: a secondary analysis of risks from 11,830 catheters, *Int. J. Nurs. Stud.* 124 (2021) 104095.
- [14] G. Ray-Barruel, et al., Effectiveness of insertion and maintenance bundles in preventing peripheral intravenous catheter-related complications and bloodstream infection in hospital patients: a systematic review, *Infect Dis Health* 24 (3) (2019) 152–168.
- [15] M. Pittiruti, et al., European recommendations on the proper indication and use of peripheral venous access devices (the ERPIUP consensus): a WoCoVA project, *J. Vasc. Access* 24 (1) (2023) 165–182.
- [16] W. Zingg, et al., Best practice in the use of peripheral venous catheters: a scoping review and expert consensus, *Infect Prev Pract* 5 (2) (2023) 100271.
- [17] J. Webster, et al., Clinically-indicated replacement versus routine replacement of peripheral venous catheters, *Cochrane Database Syst. Rev.* 1 (1) (2019) Cd007798.
- [18] Y. Lladó Maura, et al., Care bundle for the prevention of peripheral venous catheter blood stream infections at a secondary care university hospital: implementation and results, *Infect Dis Health* 28 (3) (2023) 159–167.
- [19] P. Santos-Costa, et al., Evidence-informed development of a bundle for peripheral intravenous catheterization in Portugal: a delphi consensus study, *Nurs Rep* 12 (3) (2022) 498–509.