

# Implementation of an intravenous therapy program in nephrological patients: analysis of results

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## ABSTRACT

**Objective:** To evaluate the prevalence and impact of midline catheters inserted by the Infusion and Vascular Access Team using echo-guided puncture compared to conventional intravenous strategies (peripheral venous catheter insertion by hospitalization nurses) in a nephrology and kidney transplant unit.

**Material and Method:** This is a retrospective observational study. Three periods were compared: pre-implementation, implementation, and consolidation of the Infusion and Vascular Access Team. All patients admitted to the Nephrology and Kidney Transplantation hospitalization units requiring the placement of peripheral vascular catheters and midline were included. The prevalence of venous access, dwell time, and reasons for removal (complications) were analyzed.

**Resultados:** The incidence of peripheral vascular catheters decreased while that of midlines progressively increased in all three periods. Moreover, there were no differences in the mean dwell time of peripheral vascular catheters, whereas the dwell time of midlines increased. A higher and variable rate of complications was confirmed in peripheral vascular catheters in all periods, while in midlines, the complication rate was lower and more stable.

**Conclusions:** Implementing an intravenous therapy program in nephrology patients has allowed for minimizing the number of venous devices per patient, resulting in a reduction in punctures during hospitalization and a decrease

in complications associated with venous cannulation (lower morbidity).

**Keywords:** infusion and vascular access team (IVAT); midlines (ML); peripheral vascular catheters (PVC); complications; nephrology patient.

## RESUMEN

### Implementación de un programa de terapia intravenosa en pacientes nefrológicos: análisis de los resultados

**Introducción:** Evaluar la prevalencia y el impacto del uso de líneas medias canalizadas por el Equipo de Infusión y Accesos Vasculares mediante punción eco-guiada comparada con la estrategia endovenosa convencional (punción de catéter venoso periférico por enfermeras de hospitalización) en una unidad de nefrología y trasplante renal.

**Material y Método:** Estudio observacional retrospectivo. Se compararon 3 periodos: pre-implantación, implantación y consolidación del Equipo de Infusión y Accesos Vasculares. Se incluyeron todos los pacientes ingresados en las unidades de hospitalización de Nefrología y Trasplante Renal que requirieron de la colocación de catéteres vasculares periféricos y línea media. Se analizó la prevalencia de acceso venoso, el tiempo de permanencia y los motivos de retirada (complicaciones).

**Resultados:** La incidencia de los catéteres vasculares periféricos fue decreciente mientras que el de las líneas medias se incrementó progresivamente en los tres períodos. Así mismo, no se observaron diferencias en el tiempo medio de permanencia de los catéteres vasculares periféricos mientras que la permanencia de días de la línea media se incrementó.

Se confirma en todos los periodos una tasa de complicaciones más elevada y variable en los catéteres vasculares periféricos; mientras que en la línea media la tasa de complicaciones fue menor y más estable.

**Conclusiones:** La implementación de un programa de terapia intravenosa en pacientes nefrológicos ha permitido minimizar el número de dispositivos venosos por paciente, con la consecuente reducción de punciones durante el ingreso, así como la disminución de las complicaciones asociadas a la canalización venosa (menor morbilidad).

**Palabras clave:** equipo de infusión y accesos vasculares (EIAV); líneas medias (LM); catéteres vasculares periféricos (CVP); complicaciones; paciente nefrológico.

## INTRODUCTION

Intravenous therapy (IVT) is the administration of liquid substances (used for hydration, drug administration, or nutrition) directly into a vein via a catheter, thereby enabling immediate access to the bloodstream. Compared with other routes of administration, the intravenous route is the fastest means of delivering solutions and drugs and, moreover, is the only route available for certain treatments such as transfusions. It is essential in the management of hospitalised patients, particularly those who are critically ill, chronically ill, or undergoing oncological treatment; increasingly, it is also used in the management of home-based patients<sup>1</sup>.

It is estimated that more than 70% of hospitalised patients are carriers of some form of vascular access device (VAD). For this reason, correct use and care of these devices is a fundamental issue of considerable professional interest, both for those who handle them and for healthcare managers, owing to their close association with patient safety and well-being<sup>2,3</sup>.

In the current context, VADs may be classified as short-, medium-, or long-term devices, depending on the anticipated duration of IVT. Peripheral venous catheters (PVCs) are short-term VADs inserted directly into superficial veins and indicated for IVT of < 4 days' duration, with neutral pH and osmolarity < 600 mOsm/L. Peripherally inserted central catheters (PICCs) are long-term VADs (up to 6 months) placed under ultrasound guidance, with the distal tip located in the lower third of the superior vena cava, enabling the administration of all types of solutions and drugs<sup>4</sup>. Midlines (MLs) are mid-term VADs also placed under ultrasound guidance and serve as an alternative to PVCs and PICCs<sup>4</sup>.

The use of ultrasound-guided techniques and peripheral puncture helps avoid risks such as haemothorax and pneumothorax associated with other central catheters, ensures successful puncture on the first attempt, and reduces traumatic complications related to insertion<sup>5</sup>.

Similarly, ML catheters have been associated with lower rates of phlebitis compared with short PVCs and lower infection rates than central catheters. This is because they are placed in the cephalic or basilic veins, which are deeper, larger vessels with greater blood flow. These characteristics explain the lower risk of mechanically or chemically induced phlebitis<sup>6</sup>.

In 2019, *Hospital Clínic de Barcelona* established a Cross-sectional Intravenous Therapy Programme that included a cross-sectional Infusion and Vascular Access Team (IVAT), a multidisciplinary vascular access committee, and an internal staff training programme. After patient evaluation (treatment duration and type, as well as difficulty of venous access cannulation), ward nurses may contact the IVAT for the insertion of ML or PICC lines.

Many nephrology patients require IV treatment during hospital admissions. Furthermore, they often carry vascular accesses for haemodialysis (catheters, native or prosthetic arteriovenous fistulas), which reduces the options for cannulating veins in the same limb. This situation leads to patient suffering (multiple cannulation attempts) and depletion of venous capital<sup>5</sup>. Therefore, studying the use of MLs in this population is of great interest to nursing staff, as MLs can reduce the number of venepunctures during hospital stays and minimise vascular access complications, thereby contributing to patient well-being and quality of life.

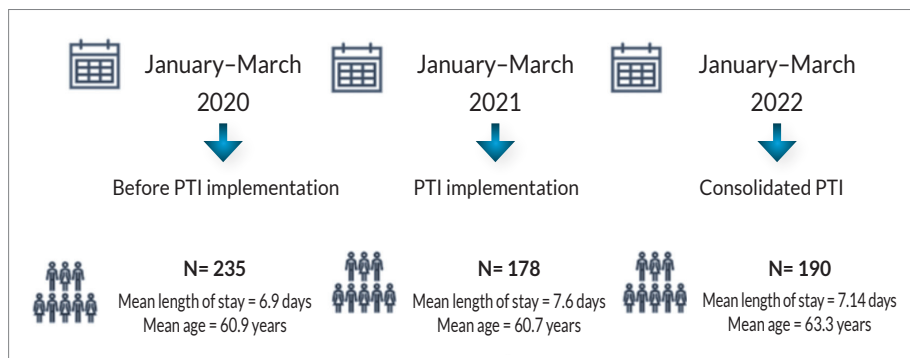
The objective of this study was to evaluate the prevalence and impact of ML use inserted by the IVAT using ultrasound-guided puncture compared with the conventional intravenous strategy (PVC puncture by ward nurses) in a nephrology and renal transplant unit.

## MATERIAL AND METHOD

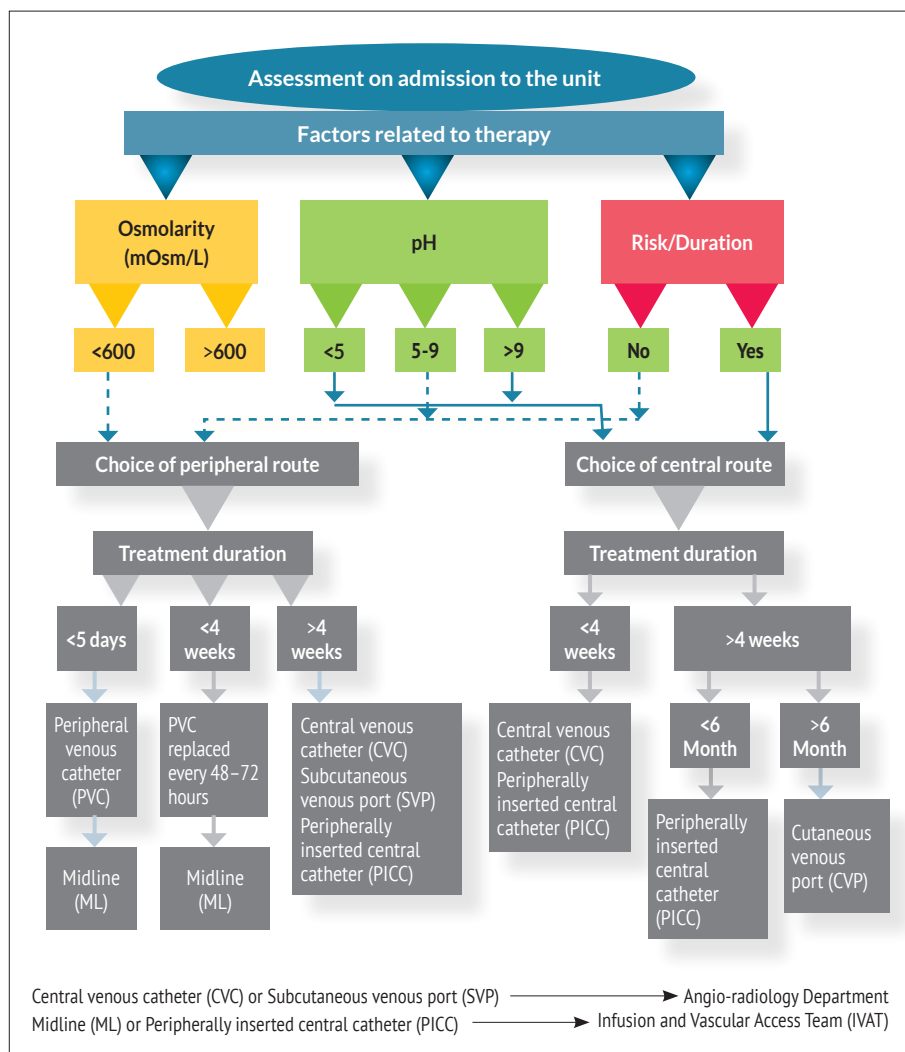
We conducted a retrospective, observational study to evaluate venous vascular accesses in hospitalised patients in the nephrology and renal transplant unit of Hospital Clínic de Barcelona, before and after the implementation of an IVAT. Three time periods were compared (**figure 1**):

- P1: prior to IVAT implementation, January–March 2020.
- P2: during IVAT implementation, January–March 2021.
- P3: IVAT consolidation, January–March 2022.

The IVAT consists of 2 morning-shift nurses (08:00–15:00), both experts in vascular access and trained in the care of oncological patients. Following application of a care algorithm (**figure 2**) by the ward nephrology nurse—assessing peripheral venous access risk and duration, as well as type of IV therapy



**Figure 1.** Graphical representation of the analysis periods together with the number of patients studied, length of stay, and mean ages.



**Figure 2.** Decision algorithm for the most appropriate vascular access, depending on the characteristics of the treatment to be administered.

according to osmolarity and pH—a telephone consultation is made to the IVAT. Within the first 24–48 hours, the expert nurse attends the ward and, after a comprehensive patient assessment, proceeds with the insertion of ultrasound-guided VADs: 10-cm ML, 20-cm ML, or double-lumen ML.

The study population included all patients hospitalised in the nephrology and renal transplant unit during the study periods (24 conventional ward beds and 3 intermediate care beds). We analysed demographic data (age), incidence and type of venous access (ML/PVC), dwell time, and reasons for removal. Reasons for removal included complications such as extravasation, phlebitis, and dysfunction.

Data were collected using the SAP/IPA software (SAP Logon Pad 770/IPA, Informatización del Proceso de Atención, Version 32).

Data analysis was performed using Microsoft Power BI. For quantitative variables, mean and standard deviation were calculated; for qualitative variables, absolute (n) and relative (%) frequencies were determined.

The study was approved by *Hospital Clínic de Barcelona* Research Ethics Committee (Approval code: HCB/2023/0732) and conducted in full compliance with the Declaration of Helsinki and the legal requirements of Biomedical Research (Law 14/2007).

**RESULTADOS**

A total of 603 patients admitted to the nephrology and renal transplant unit were studied across the 3 periods. The mean age was 61.6±15 years, with a mean length of stay of 7.21±11.11 days. During this period, 93% (561 patients) carried a PVC, while 8% (48 patients) carried an ML (considering that some patients carried both types of VAD during the same admission) (figure 3).

The mean dwell time was 3.02 days for PVCs and 8.43 days for MLs. The main reasons for device removal were end of treatment (without complications), dysfunction, extravasation, and phlebitis.

The breakdown of study variables across the three defined time periods was as follows:

■ **P1:** A total of 235 patients were analysed. The mean age was  $60.9 \pm 16.59$  years, with a mean length of stay of  $6.9 \pm 8.56$  days (Figure 4). During this period, 94% (221 patients) carried a PVC, whereas only 1% (2 patients) carried an ML (Figure 3). The mean dwell time was 3.15 days for PVCs and 6.9 days for MLs (figure 4). The complication rate for PVCs was 26% (57 patients: 46 extravasation [80%]; 11 phlebitis [20%]), while no complications were reported among the ML carriers (only 2 patients) (figure 5).

■ **P2:** A total of 178 patients were studied. The mean age was  $60.7 \pm 14.27$  years, with a mean length of stay of  $7.6 \pm 11.36$  days. PVC incidence remained at 95% (169 patients), whereas ML use increased to 8% (14 patients). The mean dwell time was 3.06 days for PVCs and 9.4 days for MLs. The complication rate for PVCs was 34% (57 patients: 33 extravasation [58%]; 14 phlebitis [24%]; 10 dysfunction [18%]), whereas for MLs it was 21% (3 patients: 2 dysfunction [67%]; 1 extravasation [33%]).

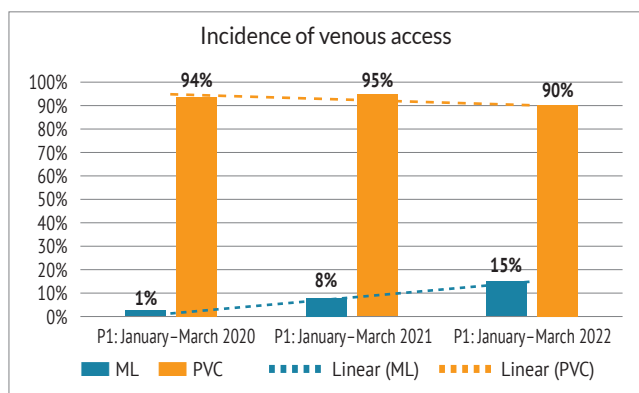


Figure 3. Incidence rate by type of device, in each of the study periods. ML: Midline. PVC: Peripheral venous catheter.

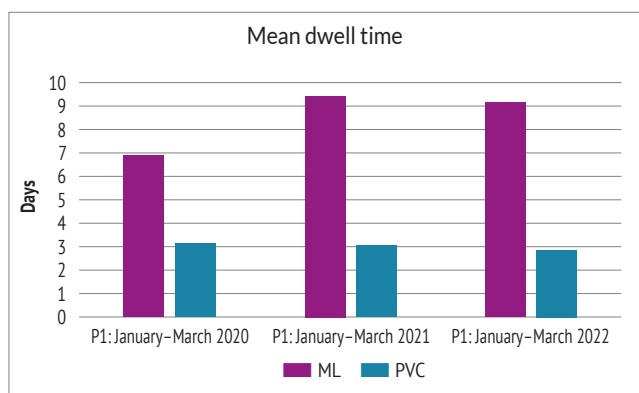


Figure 4. Mean dwell times by type of device, in each of the study periods. ML: Midline. PVC: Peripheral venous catheter.

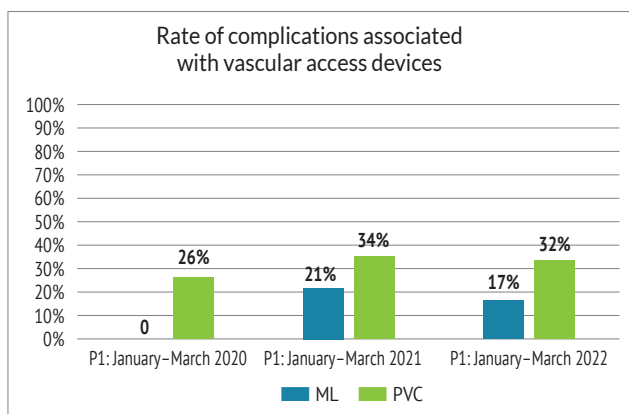


Figure 5. Incidence rate by type of device, in each of the study periods. LM: Midline. CVP: Peripheral venous catheter.

■ **P3:** A total of 190 patients were analysed. The mean age was  $63.3 \pm 13.67$  years, with a mean length of stay of  $7.14 \pm 13.18$  days. PVC incidence decreased to 90% (171 patients), while ML use increased to 15% (28 patients). The mean dwell time was 2.87 days for PVCs and 9.2 days for MLs. The complication rate for PVCs was 32% (55 patients: 29 extravasation [53%]; 12 dysfunction [22%]; 9 phlebitis [16%]; 5 other [9%]), whereas for MLs it decreased to 17% (5 patients: 3 extravasation [60%]; 2 dysfunction [40%]).

## DISCUSSION

CKD is a public health problem with an estimated prevalence of approximately 15% in Spain. Patients with CKD have a shortened life expectancy (particularly due to cardiovascular causes and infections) and are frequently hospitalised. In both outpatient and inpatient settings, CKD patients require repeated venous cannulations (for blood tests and intravenous therapies), which increases morbidity and reduces quality of life<sup>7-9</sup>.

The implementation of an Infusion and Vascular Access Team (IVAT) in other medical specialties with high venous access demands, such as haemato-oncology, has proven to be an efficient alternative to PVCs, reducing the number of associated complications.

Recent literature indicates that the use of MLs may be expanding<sup>10</sup>, although few studies have been conducted in hospitalised patients with CKD.

We present our experience with venous access placement before and after the implementation of an IVAT in a nephrology and renal transplant inpatient unit.

Across the 3 study periods, the number of hospitalised patients was very similar, as were age and mean length of stay. In period P1 (prior to implementation), nearly all patients carried PVCs (94% vs 1% with MLs). Among these,

57 patients (26%) developed associated complications (21% extravasation, 5% dysfunction). In P2 (after implementation), while the proportion of patients with PVCs remained stable (95%), those with MLs (ultrasound-guided insertion) increased from 1% to 8%. Furthermore, implementation of the IVAT was associated with a significant reduction in complications: 34% in patients with PVCs compared with only 21% in those with MLs. Notably, this effect was not temporary, as the reduction in complications was sustained during the consolidation period (P3: 32% in PVC carriers vs 17% in ML carriers). These results are consistent with previous studies in patients hospitalised in level 3 trauma units and in emergency departments, which also demonstrated a lower complication rate with MLs compared with PVCs<sup>11,12</sup>.

Another important finding of this study is the mean dwell time of vascular devices in hospitalised patients with CKD. Whereas PVCs remained in place for only 3.06 days in P2 and 2.87 days in P3, ML dwell time was much longer in the two post-implementation periods, reaching 9.4 days in P2 and 9.19 days in P3. These results align with other studies in hospitalised patients, confirming that MLs are the venous access device of choice in patients requiring IV therapy for > 6 days<sup>13,14</sup>.

The benefits of IVAT implementation lie in improving patient safety and well-being, which positively impacts perceived quality of care. Having an IVAT generally reduces associated complications; promotes safe management of patients' venous capital; prevents future complications from venous depletion; decreases the need for multiple punctures when inserting peripheral catheters; enhances patients' quality of life; increases professional satisfaction; and reduces workloads<sup>15,16</sup>.

Application of this model to other units has led to clear improvements in the quality and safety of care for hospitalised patients (fewer punctures, reduced complications, greater preservation of the vascular tree, and improved quality of life). This has resulted in the incorporation of a third nurse into the IVAT for the afternoon shift and a transition from telephone to electronic consultation requests.

The main limitation of the present study is its retrospective design and the potential biases inherent to this methodology. Moreover, it will be important in future to design prospective studies to confirm these findings and to evaluate aspects as important as patients' quality of life.

Our experience demonstrates the benefits of implementing an IVAT in a nephrology inpatient unit, particularly the reduced number of complications associated with ultrasound-guided ML placement and their longer dwell time compared with PVCs. The success of this programme has relied on the empowerment of nephrology nurses (through application of the care algorithm) and the involvement of advanced practice nurses within the IVAT.

## Conflicts of interest

None declared.

## Funding

None declared.

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