Research

Infective Risk Related to Peripherally Inserted Venous Access under Ultrasound Guidance by Trained Nurses: A Retrospective Observational Study

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Abstract

Introduction. Patients admitted to infectious diseases units frequently require prolonged intravenous therapy and repeated blood sampling, making reliable peripheral venous access essential. However, conventional peripheral cannulation is often challenging due to poor vein quality and repeated insertions. To enhance vascular access management, nurses were trained to insert peripheral venous access devices such as mini-midline and midline catheters. This study aimed to evaluate the infectious risk associated with these devices, with particular focus on catheter tip pathogen colonization.

Methods and materials. A retrospective observational study was conducted at an Infectious Diseases Clinic of a university hospital in Northeast Italy. Medical records of patients who received a mini-midline or midline catheter inserted by trained nursing staff between January and August 2023 were reviewed. Data were collected for 50 consecutive patients and included indications for catheter removal, occurrence of suspected infection, and results of catheter tip culture examinations when available. Descriptive analysis was performed to assess the incidence of suspected infection and confirmed device colonization.

Results. Among the 50 evaluated catheters, 6 (12.0%) were removed due to suspected infection. Catheter tip cultures were performed in these cases, and only one device showed microbiological growth. The single positive culture identified Staphylococcus epidermidis and was obtained from a mini-midline catheter inserted using the Seldinger technique; notably, this catheter had been removed for reasons unrelated to infection. No confirmed catheter-related infections were

documented.
Discussion. These findings suggest that mini-midline and midline catheters are associated with a low risk of infectious complications, particularly device colonization, when inserted by adequately trained nurses. This supports their safe use in patients requiring medium-term venous access in infectious diseases settings. Nevertheless, the retrospective design and limited sample size restrict the generalizability of the results. Larger, prospective studies are warranted to further confirm the safety profile of these devices.

Keyword: Mini-midline, Midline, Infective Risk, Ultrasound Guidance

Introduction

Patients admitted to the infectious diseases department often require intravenous antimicrobial therapy and frequent blood draws, both to monitor their overall clinical progress and to perform Therapeutic Drug Monitoring (TDM) of the antibiotics. For these reasons, the availability of a venous access from which it is also possible to perform blood sampling and which, at the same time, guarantees patient comfort, the lowest possible risk of infection, and the greatest temporal durability depending on the intravenous therapies for which it is used is empirically preferable. In terms of peripheral venous access, in addition to the commonly used Peripheral Intravenous Catheter (PIV), midline and mini-midline catheters also known as long peripheral cannulas (LPCs) have become increasingly widespread in recent years. The mini-midline devices represent an intermediate option between PIVs and midlines, with lengths ranging from 6 to 15 cm and a dwell time of up to 4 weeks. For comparison, PIVs in terms of length range from 4.8 cm to 6.35 cm, and the average postinsertion lifespan is approximately 60–96 h. While midlines range from 8 to 12 cm, and the average postinsertion lifespan is about 7 to 14 days. They are typically inserted in the arm under ultrasound guidance using the Seldinger technique (Quin et al., 2019). Some studies in the literature show that mini-midlines placed under ultrasound guidance have better performance compared to traditional PIV in various aspects, especially in patients with poor venous access (Badger, 2019; Qin et al., 2021). The use of ultrasound for implanting these devices also appears to have a preventive effect against thrombophlebitis, extravasation, and site infection without bacteremia, and overall is associated with a lower risk of complications (Scoppettuolo et al., 2016).

As indicated by the Italian GAVeCeLT group ("Gli Accessi Venosi Centrali a Lungo Termine"), a mini-midline should be placed in any hospitalized patient (whether a DIVA patient, i.e. Difficult IntraVenous Access patient, or a non-DIVA patient) requiring intravenous drug administration with a treatment duration > 7 days or in DIVA patients even for treatments lasting < 48 hours (GAVeCeLT, 2024). For this reason, given the short duration of antimicrobial therapies performed in this clinic -which varies from one week, up to three to four weeks- in 2022, several nurses from the Infectious Diseases Clinic at Udine Hospital were trained in the placement of these devices. They subsequently implanted them in various patients, optimizing their care. In this study, we evaluated the safety of these devices by assessing the infectious risk related to their placement, as described, in terms of pathogenic colonization. Given the lower risk associated with peripheral access compared to central lines, the longer dwell time of mini-midlines, and the relative simplicity of their placement (whether using all-in-one devices or the Seldinger technique) as well as the increased patient comfort, our objective was to formally validate the use of this device for infusion therapy and to promote its wider adoption.

Methods and materials

This retrospective study was reported in accordance with the STROBE (Strengthening

the Reporting of Observational Studies in Epidemiology) checklist for observational studies (von et al., 2014).

Data collection occurred by consulting the medical records of patients admitted to the Infectious Diseases Clinic at Udine Hospital from January to August 2023. The admission regimen could be either regular (ordinary) or day hospital. The inclusion criteria consisted of patients who: 1) were aged ≥ 18 years, 2) were admitted to the study centre, and 3) required placement of one of the devices under study. Out of the 91 eligible patients, 50 were included in the study (Figure 1).

The implanted devices were of three different types: "All in One" mini-midline (PowerGlide Pro™ Midline Catheter 18G – 10cm, SKU/REF F218108PT – BD), mini-midlines placed using the Seldinger technique (Leader-Cath® artero-venous in PE 18G - 10cm, REF 115.11 – Vygon), and midlines (PowerMidline™ Catheter 4Fr/18G - 20cm single-lumen, REF P6154118 – Bard). A higher proportion of patients receiving "All in One" devices were treated for multiple medications or frequent blood draws (58.3%) compared to those receiving other devices for poor venous access (57.9%). To assess the infectious risk, it was decided to include in the analyses only those devices for which the tip was sent for culture examination.

The data were collected by completing a checklist on the EUSurvey platform. This is a free, online survey management platform developed by the European Commission's DG DIGIT under the ISA^2/Digital Europe programmes. The checklist gathered data from three distinct phases of the process: device placement (patient-related characteristics such as age, gender, originating department, reason for admission, medical history, and details about the implanted device), removal of the device (including data and reasons for removal), and the outcome of the culture examination. The data collected in this study concern exclusively devices whose tip was subjected to post-removal culture in the laboratory. The catheter tip culture analysis involves incubating the catheter tip in a sterile environment to detect and identify microbial growth, helping to diagnose potential infections. This allowed the verification of potential colonization by pathogen of the device, indicating the mere presence of microorganisms inside the catheter (Pittiruti et al., 2017). To confirm the presence of an infection, a diagnosis of Catheter-Related Bloodstream Infection (CRBSI) must be made, i.e. a blood test which shows that the catheter itself is conclusively the cause of the bloodstream infection. The diagnosis of catheter-related bloodstream infection (CRBSI) requires both clinical symptoms and laboratory evidence. (Centers et al., 2024; Pittiruti et al., 2017), typically based on the Differential Time to Positivity (DTP) method. This involves obtaining blood cultures from both the suspected venous access device and a peripheral vein, allowing the laboratory to assess the time difference in culture positivity.

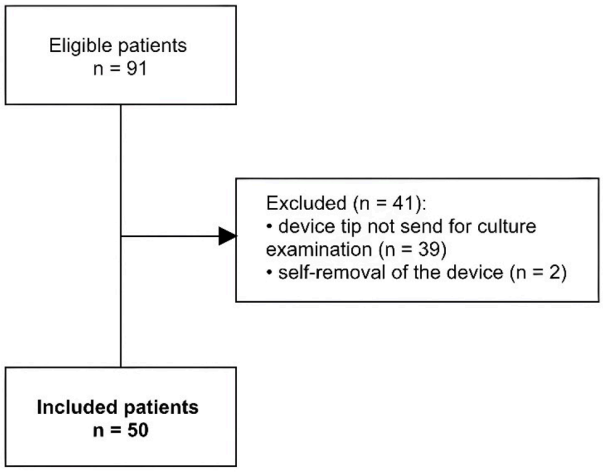

Figure 1. Patient selection flow-chart.

Statistical Analysis

We tested the normal distribution of continuous variables using the Shapiro-Wilk test. This is a statistical test for normality. It assesses whether a dataset comes from a normally distributed population by calculating a W statistic based on the correlation between the ordered sample values and the expected values from a normal distribution. Low W values indicate deviations from normality (Shapiro et al., 1965). As the sample size was < 5000, normally distributed variables were presented with the mean and standard deviation (±SD), while non-normally distributed ones were represented with the median and interquartile range (IQR).

For categorical and dichotomous variables, absolute frequency (n) and relative percentage (%) were reported. Categorical variables represent distinct groups (e.g., blood type, profession), while dichotomous variables have only two possible values (e.g., yes/no, male/female) (Shapiro et al., 1965).

Results were classified depending on the setting

(clean or sterile enviroment) and also depending on the type of device and technique (all-in-one, Seldinger adapted formini-midlines, Seldinger for midlines). Statistical significance was defined as $p < 0.05$. Statistical analyses were performed using the software "R" version 4.2.2 "Innocent and Trusting" (The R Foundation for Statistical Computing - 31/10/2022) with the assistance of the "R Commander" package (Rcmdr) version 2.8-0. Categorical variables were compared using the Chi-square test when appropriate.

The aim of the analysis was to assess the relevance of the collected data in order to understand the risk of systemic colonization associated with these devices, while acknowledging their well-established benefits.

Ethical Considerations

The Institutional Review Board of the Department of Medicine at the University of Udine (protocol 15/2024, Title III class 13 file 209/2024) approved this study. Given the retrospective design of this study, the requirement for informed consent was waived, and an opt-out approach was utilized instead.

Results

During the 8-month study period, from January to August 2023, a total of 91 devices were placed. However, only the tips of 50 devices were sent for culture analysis; therefore, only these 50 cases were included in the present analysis (Table 1). Among these, the most frequently implanted device type was the mini-midline inserted using the Seldinger technique (n = 37; 74.0%), followed by the "All-in-One" mini-midline (n = 12; 24.0%), and, in one case (n = 1; 2.0%), a midline catheter.

The indication for device placement differed by device type. The decision to place either an "All-in-One" mini-midline or a mini-midline using the modified Seldinger technique was based on the operator's confidence with the procedure and the availability of supplies in stock. Among patients who re-ceived the "All-in-One" mini-midlines, 7 out of 12 (58.3%) were treated for the need of multiple drug administrations and/or frequent blood draws. Conversely, 22 out of 38 patients (57.9%) who received either Seldinger-placed mini-midlines or the single midline had poor venous access. Most of the devices were equipped with a dual-lumen extension (n = 42; 84.0%). This is an accessory that provides two separate channels (lumens) for infusions, allowing simultaneous administration of different fluids or medications through a single vascular access point. In the majority of cases, a standard dressing was used at the exit site (n = 35; 70.0%). This a secure, low-profile adhesive dressing that stabilizes the device while keeping the exit site visible for monitoring (GAVeCeLT, 2024). Only 6 out of 50 devices (12.0%) were removed due to suspected infection, with symptoms including fever, chills, elevated white blood cell count, and signs of systemic inflammation at the time of assessment. However, none of them tested positive on culture. Of the 6 devices removed, the only tip that tested positive in the aforementioned examination was a Seldinger-technique-placed mini-midline in a patient undergoing numerous infusions and/or blood draws from the same device. It was removed after 12 days due to discontinued utility (Table 2). The majority of the remaining devices were removed due to discontin-ued utility (n = 31; 62.0%), followed by those removed for occlusion/dysfunction (n = 9; 18.0%), and finally, those removed due to displacement/outside the vein (n = 4; 8.0%). The overall median dwell time for the devices was 11.50 days [IQR 7.00 – 16.00 days]. At the time of removal, the exit site showed no signs of inflammation in 42 devices (84.0%), while the remaining devices showed visible redness and swelling < 1 cm around the exit site. A higher proportion of patients receiving "All in One" devices were treated with multiple medications or received frequent blood draws (58.3%) compared to those receiving other devices for poor venous access (57.9%). According to the Visual Exit Site Score (VESS), most devices (84.0%) showed a score of 0, while 16.0% had mild redness < 1 cm (score 1).

Discussion

Our study reached similar conclusions to those in the literature. Ultrasound-guided mini-midlines have shown better performance than traditional PIVs, especially in patients with poor venous access (Badger, 2019; Qin et al., 2021). This device appears to lower the risk of complications such as thrombophlebitis, extravasation, and site infections (Scoppettuolo et al., 2016). In both our study and that by Qin K. R. et al. (2021), most mini-midlines (62.0% and 73.1%, respectively)

Table 1. Classification of results based on the positioned device (part 1).

Patient characteristics	"All in one" Mini-midline n = 12 (100.0%)	Mini-midline Seldinger technique or Midline n = 38 (100.0%)	p-Value
Years, media [± SD]	60.25 [± 13.46]	62.53 [± 17.55]	0.682
Male sex, n (%)	11 (91.7)	23 (60.5)	0.074
Weight (Kg), median [IQR]	73.50 [57.75 – 81.50]	75.00 [59.25 – 81.50]	0.532
Height (m), media [± SD]	1.73 [± 0.07]	1.71 [± 0.09]	0.612
BMI, median [IQR]	23.30 [21.40 – 25.77]	24.30 [21.83 – 29.33]	0.658
Patient arriving from, n (%):			
Emergency department	6 (50.0)	15 (39.5)	0.904
Other hospital department	2 (16.7)	9 (23.7)	
Home	2 (16.7)	9 (23.7)	
Intensive Care Unit (ICU)	2 (16.7)	5 (13.1)	
Reason for hospitalization, n (%):			
Bacterial infection	9 (75.0)	31 (81.6)	0.388
Viral infection	2 (16.7)	7 (18.4)	
Infection of another origin	1 (8.3)	0 (0.0)	
Fungal infection	0 (0.0)	0 (0.0)	
Type of hospitalization, n (%):			
Ward	11 (91.7)	34 (89.5)	1.000
Day hospital	1 (8.3)	4 (10.5)	
Medical history, n (%):			
Cardiovascular diseases	7 (58.3)	23 (60.5)	1.000
Endocrine, nutritional or metabolic diseases	5 (41.7)	21 (55.3)	0.514
Immunological diseases	4 (33.3)	11 (28.9)	1.000
Neurological, mental or behavioral diseases	3 (25.0)	12 (31.6)	1.000
Musculoskeletal diseases	3 (25.0)	12 (31.6)	1.000
Hematological diseases	3 (25.0)	10 (26.3)	1.000
Gastrointestinal diseases	5 (41.7)	8 (21.1)	0.256
Oncological diseases	4 (33.3)	9 (23.7)	0.707
Respiratory diseases	2 (16.7)	10 (26.3)	0.705
After device placement			
Reason for device placement, n (%):			
Poor venous access	3 (25.0)	22 (57.9)	0.055
Numerous infusions and/or blood tests	7 (58.3)	15 (39.5)	
Other reasons	2 (16.7)	1 (2.6)	
Days of hospitalization before device placement, median [IQR]	2.50 [1.00 – 6.00]	3.50 [1.00 – 11.00]	0.373
Number of times the patient was punctured for device placement, median [IQR]	1.00 [1.00 – 1.00]	1.00 [1.00 – 1.00]	0.550
Use of ultrasound for placement, n (%):			
Yes	11 (91.7)	38 (100.0)	0.240
No	1 (8.3)	0 (0.0)	
Patient's dominant arm, n (%):			
Right	12 (100.0)	37 (97.4)	1.000
Not evaluable	0 (0.0)	1 (2.6)	
Left	0 (0.0)	0 (0.0)	
Arm in which the device was placed, n (%):			
Left	6 (50.0)	22 (57.9)	0.743
Right	6 (50.0)	16 (42.1)	

Table 1. Classification of results based on the positioned device (part 2).

Patient characteristics	"All in one" Mini-midline n = 12 (100.0%)	Mini-midline Seldinger technique or Midline n = 38 (100.0%)	p-Value
Site of device placement, n (%):			
Arm	8 (66.7)	38 (100.0)	0.002
Forearm	4 (33.3)	0 (0.0)	
Type of connector applied to the device, n (%):			
Dual-lumen extension (Octopus)	12 (100.0)	30 (78.9)	0.173
Needle free connector	0 (0.0)	9 (23.7)	0.092
Type of dressing applied to the device, n (%):			
Basic	11 (91.7)	24 (63.2)	0.079
With chlorhexidine patch	1 (8.3)	14 (36.8)	
Experience of the nurse who implanted the device (years of work), median [IQR]	3.00 [2.75 – 4.25]	12.00 [2.25 – 12.00]	0.125
After device removal			
Exit-site (according to the Visual exit-site score), n (%):			
Intact, healthy skin	10 (83.3)	32 (84.2)	1.000
Reddening < 1 cm around exit-site (± fibrin)	2 (16.7)	6 (15.8)	
Reddening > 1 cm around exit-site (± fibrin)	0 (0.0)	0 (0.0)	
Reddening, secretion and pus (± fibrin)	0 (0.0)	0 (0.0)	
Duration in place (days), median [IQR]	9.50 [6.00 – 14.25]	12.00 [7.25 – 17.75]	0.363
Main reason for removal, n (%):			
Discontinued utility	10 (83.3)	21 (55.3)	0.132
Occlusion and/or malfunction	0 (0.0)	9 (23.7)	
Suspected infection	2 (16.7)	4 (10.5)	
Displacement and/or device out of vein	0 (0.0)	4 (10.5)	
Use, n (%):			
Administration of antibiotics and/or antivirals and/or antifungals and/or other antimicrobials	10 (83.3)	34 (89.5)	0.621
Blood tests	10 (83.3)	32 (84.2)	1.000
Administration of blood and/or blood products	3 (25.0)	8 (21.1)	1.000
Administration of parenteral nutrition (partial and/or total)	0 (0.0)	2 (5.3)	1.000
Culture result (tip), n (%):			
Negative	12 (100.0)	37 (97.4)	1.000
Positive	0 (0.0)	1 (2.6)	

Legend: **n**: absolute frequency; **%**: relative percentage frequency; **SD**: Standard Deviation; **IQR**: Interquartile Range; **BMI**: Body Mass Index.

were removed due to completion of intravenous therapy. Regarding infections, findings across the literature are consistent: mini-midlines appear to be safe devices, with low CRBSI rates reported—0.72 (Fabiani et al., 2020) and 0.96 per 1000 catheter-days (Fabiani et al., 2017). One study recorded only a single CRBSI event (Fabiani et al., 2017), and another reported no infectious complications at all (Scoppettuolo et al., 2016). In both Qin K. R. et al. (2021) and our study, most mini-midlines (73.1% and 62.0%, respectively) were removed after completing therapy. Regarding infections, the literature consistently supports the safety of mini-midlines, with low CRBSI rates of 0.72 (Fabiani et al., 2020) and 0.96 per 1000 catheter-days (Fabiani et al., 2017). Notably, one study reported only a single CRBSI episode (Fabiani et al., 2017), while another found none (Scoppettuolo et al., 2016). However, it is not possible to make a direct comparison with our study regarding this topic for several reasons: firstly, due to the definition of CRBSI. This is defined as a primary bloodstream infection directly attributable to an intravascular catheter, confirmed by matching pathogens cultured from the catheter and blood samples, indicating the catheter as the infection source (O'Grady et al., 2009). Secondly, regarding

Table 2. Outcome of the single positive culture examination with patient characteristics.

Culture outcome	
Type	Staphylococcus Epidermidis (MLSb phenotype, methicillin-resistant)
Bacterial charge	1400 CFU/mL
Resistant to (MIC value)	Erythromycin (> 4), gentamicin (> 4), levofloxacin (2), oxacillin (2), moxifloxacin (0.5)
Sensitive to (MIC value)	Trimethoprim-sulfamethoxazole (1), linezolid (< 1), teicoplanin (0.5), doxycycline (≤ 0.5), vancomycin (≤ 0.5), fusidic acid (≤ 0.25), daptomycin (≤ 0.25), tigecycline (≤ 0.125), rifampicin (≤ 0.0625)
Patient characteristics	Male, 49 years old. BMI 22 (60 kg x 1.65 m). Coming from another department and admitted for bacterial infection. Endocrine, nutritional or metabolic diseases in medical history. Five days after admission, a Seldinger-technique mini-midline was placed on the left arm (dominant arm: right) for numerous infusions/blood tests. Two attempts were made to place it. A dual-lumen extension (octopus) was connected to the device, and a simple dressing was applied. After 12 days, the device was removed due to discontinued utility. The exit site of the device showed no signs of inflammation and the surrounding skin was intact. The device was used for blood tests, administration of antimicrobials and blood/ blood products transfusions.

the incidence rate of the phenomenon. Our study only evaluated the positivity of the culture examination conducted on the tip of the device once removed, calculating the percentage of results. This is certainly a significant limitation as we cannot affirm the presence of CRBSI but only the potential colonization of the catheter, which occurred in 1 case out of 50 (2.0%). Moreover, signs of infection such as fever or an increase in inflammatory markers were not detected. However, since the only positive result was Staphylococcus epidermidis, a common skin commensal (O'Grady et al., 2002), we cannot be certain whether this reflects true catheter colonization or sample contamination. It is also noteworthy that from the classification performed, overall, no statistically significant differences emerged between those devices placed in a clean environment (mini-midline "All in one") and those placed in a sterile environment (the remaining mini-midlines and the midline) since just one tip tested positive.

Limits of the study

This study has several limitations. First, its retrospective and monocentric design may limit the gener-alizability of findings. Second, the sample size was relatively small, and the number of midlines included was insufficient for proper comparison with mini-midlines. Third, the absence of data from other vascular access devices (e.g., PIVs or PICCs) precludes meaningful comparisons. Furthermore, although catheter tip cultures were analyzed, no differential time to positivity (DTP) was performed, limiting the ability to confirm catheter-related bloodstream infections (CRBSI). Some devices could not be used for blood sampling due to occlusion, making DTP technically unfeasible. Finally, no data were col-lected on clinical signs or symptoms (e.g., fever, chills, inflammatory markers) to correlate colonization with clinical infection.

Another limitation of this study is the inability to directly compare the results with other vascular accesses, such as PIVs or central lines (e.g., Peripherally Inserted Central Catheters), since these were not included. Comparisons were therefore possible only using data available from the literature. The small sample size and the study's design also certainly influenced the results. In conclusion, future studies should include a greater number of midlines to enable a direct comparison with mini-midlines.

Conclusion

Mini-midlines appear to be valid and safe devices for patients requiring short-term intravenous therapy and for those with poor venous access. However, given the numerous limitations of this study, further research is needed to more adequately explore the topic.

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