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Incidence, complications, and costs of peripheral venous catheter-related bacteraemia: a retrospective, single-centre study

B. Drugeon [a,b], J. Guenezan [a,b,c], M. Pichon [b,c,d], A. Devos [a], X. Fouassin [e], A. Neveu [e], L. Boinot [e], V. Pratt [e], O. Mimoz [a,b,c,*]

[a] CHU de Poitiers, Service des Urgences et SAMU 86, Poitiers, France
[b] Université de Poitiers, INSERM U1070, Pharmacologie des Agents Anti-Infectieux et Résistance (PHAR2), Poitiers, France
[c] Université de Poitiers, UFR de Médecine-Pharmacie, Poitiers, France
[d] CHU de Poitiers, Département des Agents Infectieux, Laboratoire de Bactériologie-Hygiène, Poitiers, France
[e] CHU de Poitiers, Direction du Système D'Information – Dossiers Patient, Poitiers, France

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SUMMARY

Background: Peripheral venous catheter (PVC) complications occur on average in approximately half of patients, necessitating premature PVC removal, suspending administration of ongoing therapies, and catheter replacement.
Aim: To estimate the current incidence, complications, and costs of bloodstream infection (BSI) attributable to PVCs.
Methods: Patients with PVC-related BSI (cases) were matched with patients without PVC-related BSI (controls).
Findings: From January 1st, 2018 to March 31st, 2020, a total of 9833 out of 113,068 patients visiting the emergency department (9%) were hospitalized in a medical ward after insertion of a PVC. Among them, 581 (6%) had at least one positive blood culture. Twenty-five (4%) of these were judged as having a PVC-related BSI. Major complications were noted in nine patients. One patient presented severe sepsis requiring admission to intensive care unit for eleven days followed by thoracic (T4–T7) spondylodiscitis requiring prolonged antimicrobial therapy. Another patient developed mitral valve endocarditis also requiring prolonged antimicrobial therapy. One patient developed a pre-sacral abscess three months after initial PVC infection and required hospital readmission for 19 days for drainage. Median (interquartile range) hospital stay costs were €11,597 (8,479–23,759) for cases and €6,789 (4,019–10,764) for controls, leading to median additional costs of €5,587.
Conclusion: Though the risk of developing PVC-related BSI in patients admitted to medical wards may seem low, complications of PVC-related BSI are severe, and associated mortality remains high. The financial resources used to treat these complications could be better spent on prevention, including the use of high-quality materials and technologies, and improved training of healthcare providers.

* Corresponding author. Address: CHU de Poitiers, Service des Urgences et SAMU 86, Poitiers, France. Tel.: +33 5 49 44 46 00.
E-mail address: Olivier.MIMOZ@chu-poitiers.fr (O. Mimoz).

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Introduction

Peripheral venous catheters (PVCs) are the most widely used invasive medical device in hospitals. Up to 90% of hospitalized patients require a PVC. Each year, two billion catheters are sold worldwide, including 25 million in France alone [1—4].

For a long period of time, these devices have been considered as 'safe'. However, complications occur on average in approximately half of patients, necessitating premature PVC removal, suspending administration of ongoing therapies, and catheter replacement [5]. A recent meta-analysis estimated occurrence of phlebitis at 19%, extravasation at 14%, occlusion at 8%, leakage at 7%, pain at 6% and catheter displacement at 6% [6].

Infectious complications are much rarer, but their consequences are potentially severe. Occurrence of PVC-related bloodstream infections (BSIs) has been associated with increased duration of hospital stay, mortality, and costs [7]. In the 2012 point prevalence survey of healthcare-associated infections and antimicrobial use in European acute care hospitals conducted by the European Centre for Disease Prevention and Control, 6% of healthcare-associated BSIs were reported to be PVC-related [8]. A review of the literature estimated the PVC-related BSI incidence at 0.18% among 85,000 catheters studied, but it included some earlier studies in which not all current recommendations for catheter care had been applied [9]. Although the risk of PVC-related BSI is classically lower (fewer than 0.5 episodes per 1000 catheter-days) than with other intravascular devices (up to 2.7 episodes per 1000 catheter-days for central venous catheters (CVCs)), the total number of PVCs used worldwide means that the total number of PVC-related BSIs is close to, or even greater than, the number of CVC-related BSIs [10]. Prevention of this complication is therefore a major health issue.

The aim of the present study was to estimate the current incidence, complications, and costs of BSI attributable to PVC inserted in patients visiting our emergency department and requiring hospital admission in a medical ward, a hospital using an institutional protocol for PVC insertion, and maintenance based on all the current recommendations for PVC care.

Methods

This was an observational, retrospective, single-centre study at Poitiers University hospital, a 956-bed acute care hospital located in France. The adult emergency department has 50,000 visits per year on average. Approximately 30% of patients require hospitalization, more than half of them in a medical ward, generally after insertion of a PVC. In accordance with French law, due to the retrospective design of the study, ethics committee approval was waived, but the study obtained approval from the hospital data protection officer, as requested.

In order to standardize practices within the institution, the Poitiers University Hospital has a protocol (available on all computers of the establishment) for insertion and maintenance of PVCs based on the latest French national recommendations [11,12]. Briefly, nurses should rub their hands with a hydro-alcoholic solution before any handling of the infusion line. Hair at catheter insertion site should be removed with clippers only if needed. Skin disinfection should be vigorously carried out with alcoholic chlorhexidine (preferred) or alcoholic povidone iodine for ≥30 s. PVCs (Insyte™ Autoguard™ BC Winged; Becton Dickinson, Le Pont de Claix, France) are inserted when the work area is dry, and then fixed with sterile adhesive strips (Steri-strip™; 3M, St Paul, USA) and taped with transparent film dressing (Tegaderm™ 1626W; 3M); following which, PVCs should be monitored and reassessment of the appropriateness of maintaining the catheter should be done daily. Three-way stopcocks, valves and caps should be handled with sterile swabs impregnated with alcoholic antiseptics. The infusion line should be flushed after each treatment administration. PVCs and infusion lines should be routinely changed every four days whenever possible. Dressings should be changed every four days or earlier if soiled, wet, or loose. Caregivers are asked to fill in the catheter monitoring and traceability form (skin condition, date of insertion, type of catheter, site of insertion, daily monitoring, any interventions on the catheter, date of removal, identity of the operator) daily.

For the study, all adult (≥18 years) patients of both sexes visiting our emergency department from January 1st, 2018 to March 31st, 2020 (before the COVID-19 pandemic) were included, and requiring a PVC followed by hospital admission in a medical ward. Patients requiring transfer to a surgical ward or to the intensive care unit (ICU) before the diagnosis of PVC-related BSI were excluded. Patients were monitored throughout their hospital stay and all their PVCs were included for the occurrence of PVC-related BSI.

All patients' records meeting the inclusion criteria and none of the exclusion criteria were extracted from the emergency department software (Resurgences®; Berger-Levrault, Paris, France). The selected records were then cross-referenced with the blood culture database from the microbiology laboratory software, using the patients' unique hospital identifier (UPI).

All the files with one or more positive blood cultures were independently reviewed by three senior emergency department physicians (B.D., J.G., O.M.) to classify the cases as 'contaminant' or 'true bacteraemia' related or not to a PVC. Clinical and microbiological data necessary to classify the cases during the stay in medical wards were extracted from Telemaque® (Softway Medical, Meyreuil, France) and Hopital Manager® (Softway Medical), and from CyberLab® (CliniSys, Vincennes, France), respectively. All cases with a suspicion of PVC-related BSI were adjudicated by the three emergency department physicians during four 2 h meetings.

The primary endpoint was to estimate the incidence of PVC-related BSI, which was defined as a combination of (all items required): (i) fever (body temperature ≥38.5 °C) or hypothermia (body temperature ≤36.5 °C), chills or hypotension (systolic blood pressure <90 mmHg); (ii) one or more positive peripheral blood cultures drawn 48 h before or after catheter

withdrawal; (iii) isolation of the same organism (same species and same antibiotic susceptibility testing profile) from the colonized catheter or from the catheter insertion site culture (in the absence of culture, the presence of infectious signs (such as redness, phlebitis or purulent discharge) at catheter insertion site was required); and (iv) no other source of infection. In patients with bacteraemia due to commensal micro-organisms (coagulase-negative staphylococci, *Corynebacterium* spp. (except *C. jeikeium*), *Lactobacillus* spp., *Bacillus* spp. and *Propionibacterium* spp., or viridans group streptococci or *Clostridium perfringens*), at least two positive cultures from separate blood samples were required to define a true BSI.

Secondary endpoints were: (1) To describe the characteristics, type of causative micro-organisms and consequences of PVC-related BSI in patients requiring admission to a medical ward after visiting an adult emergency department. For that purpose, phlebitis was defined as the simultaneous presence of two or more of the following: (i) patient-reported pain or tenderness with a severity of two or more on a ten-point scale; (ii) erythema around the insertion site; (iii) swelling around the insertion site, (iv) purulent discharge, or (v) palpable venous cord beyond the intravenous catheter tip. Secondary septic disseminations were recorded, having been defined as infections due to a micro-organism identical to the one from PIV-BSI, occurring during or after hospitalization, without time limit, and managed at the University Hospital of Poitiers. They had to be clearly identified as secondary complications in the hospital reports and supported by additional examinations (imaging and biology). (2) To estimate PVC-related BSI costs. For this purpose, patients with PVC-related BSI (cases) were matched with patients without PVC-related BSI (controls). Matching criteria were as follows [13,14]:

- Hospital admission through the emergency department.
- Age within five years. When the search method did not find a similar patient in this age range, it was extended.
- Same level of comorbidities as assessed by the Charlson Index [15,16].
- Admission to the same medical ward.
- Same homogeneous patient group classification and type of hospitalization (medical or surgical).
- Same year of hospitalization. When the search method did not find a similar patient, it was extended to the year before or after.
- Hospital length of stay at least as long as time to BSI onset.

All controls with all matching criteria were included in the cost analysis to avoid selection bias and improve average costs estimate. PVC-related BSI costs were estimated by the median of differences between hospital stay costs of cases and median hospital stay costs of corresponding controls. Costs of hospital readmissions and of hospital-at-home interventions in connection with the infected catheter were also taken into account. Costs related to the structure and investments were excluded as they are not directly related to medical care.

Individual hospital stay costs were estimated according to a national methodology by adding up costs associated with:

- Care in the medical wards and critical care units. These costs are based on the number of hospital days spent in each medical unit attended. For each medical unit, the average cost of an inpatient day is calculated for a given year based on expenditures on medical, nursing and administrative staff, medical devices, and usual treatment.
- Use of high-cost drugs, implantable medical devices, and blood products.
- Use of medical–technical facilities (anaesthesia, operating room, laboratories, imaging, functional explorations).
- Medical logistics (pharmacy, sterilization, biomedical, hygiene).
- General logistics (laundry, catering, administrative services, transport, stretcher unit).

Statistics

The aim was to collect 25–50 patients having developed PVC-related BSI during their hospital stay in a medical ward after visiting our emergency department. Assuming a risk of PVC-related BSI of 0.2%, 12,500–25,000 admissions of patients in a medical ward were required. The emergency department of the Poitiers University Hospital counts 50,000 visits per year, of which 30% entail hospitalization, i.e. approximately 15,000 admissions per year [17]. Most of them have a PVC inserted in the emergency department and more than half are admitted to a medical unit. The inclusion period was extended to 27 months. Because of decreased emergency department attendance, changes of patient characteristics and pressures on quality of care during the COVID-19 pandemic, inclusions were stopped at the end of March 2020.

Quantitative variables are recorded by their median and interquartile (IQR) range and compared using the Mann–Whitney *U*-test. Categorical variables are described in numbers and percentages and compared using the χ^2-test.

Results

During the study period, 9833 out of 113,068 patients visiting the emergency department (9%) were hospitalized in a medical ward after insertion of a PVC (Figure 1). Among them, 581 (6%) had at least one positive blood culture and their medical records were reviewed. Unanimously, 429 patients (74% of all patients with a positive blood culture) were adjudicated as having a BSI from a source other than the PVC, 127 (22%) as having a contaminated blood culture, and 25 (4%) as having a PVC-related BSI.

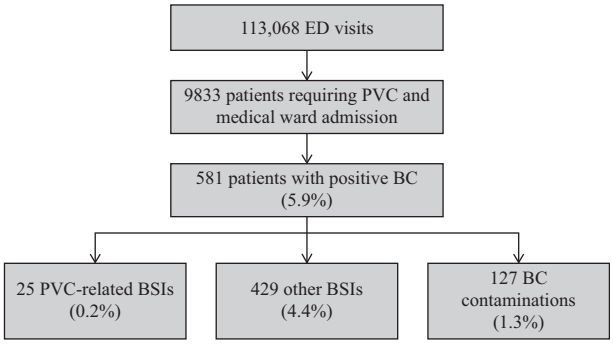

Figure 1. Study flow chart. ED, emergency department; PVC, peripheral vascular catheter; BSI, bloodstream infection; BC, blood culture.

Characteristics of patients with PVC-related BSI are presented in Table I. Patients were mainly elderly men with several comorbidities as assessed by their Charlson Comorbidity Index (median (IQR): 3 (2–5)). Their median length of stay in hospital was 21 (16–34) days.

Characteristics of PVC-related BSI are reported in Table II and Supplementary Table S1. Six patients (24%) were receiving antibiotics before catheter placement. All but one of the catheters involved were placed in the upper limbs, mainly during daytime. Catheters inserted in the emergency department were involved in almost half of cases. Median time from hospital admission to onset of infection was 7 (4–12) days. Local signs at catheter insertion site were presented in all cases. Staphylococci were the micro-organisms responsible for 90% of infections, with *Staphylococcus aureus* accounting for three-quarters of the staphylococci involved. Only 24 patients were receiving antibiotic treatment (Supplementary Table S2). One patient with a coagulase-negative staphylococcal infection was discharged from the hospital the day after infection onset without having received antibiotics. The patient was not readmitted to the hospital in the following weeks. Five patients required a central venous access for antimicrobial administration. Anti-infective treatment was adjusted once in eleven patients (44%), twice in three (12%), and three times in two patients (8%) (Supplementary Table S2). Antimicrobial therapy was continued after hospital discharge in five patients, including two with at-home hospitalization. All in all, anti-infective treatment was administered for a median length of 14 (7–20) days.

Several investigations were performed to detect complications in connection with PVC-related BSI (Table III). They were mainly cardiac ultrasounds ($N = 14$, for twelve patients) and body computed tomography (CT) and/or positron emission tomography CT scans ($N = 8$, for five patients).

Major complications were noted in nine patients (Table IV). One patient presented severe sepsis requiring admission to ICU for eleven days followed by thoracic (T4–T7) spondylodiscitis requiring prolonged antimicrobial therapy. Another patient developed mitral valve endocarditis also requiring prolonged antimicrobial therapy. One patient developed pre-sacral abscess three months after initial catheter infection and required hospital readmission for 19 days for drainage. *Staphylococcus aureus* was the micro-organism responsible in these three cases. Six cases (24%, including three due to *S. aureus*) died during their hospital stay. The median (range) time to death after onset of sepsis was 7 days (5–9) and all deaths occurred within 45 days of infection without formal identification of the death aetiology retrospectively. In at least one patient, however, death was secondary to limitation of active therapies due to the occurrence of PVC-related BSI complications.

For estimation of additional costs, three of the 25 cases with PVC-related BSI had to be excluded. For one patient, a control

Table I
Characteristics of patients with a peripheral venous catheter-related bloodstream infection ($N = 25$)

Variable	No. (%) or median (range)
Age (years)	73 (52–88)
Male sex	18 (72)
Charlson Comorbidity Index	3 (2–5)
Reason for hospital admission	
Cardiac	6 (24)
Respiratory	1 (4)
Gastrointestinal	4 (16)
Rheumatological	1 (4)
Neurological	5 (20)
Renal	3 (12)
Infectious	3 (12)
Metabolic	1 (4)
Haematological	1 (4)
Length of stay in hospital (days)	21 (16–34)

Table II
Characteristics and treatment modalities of peripheral venous catheter-related bloodstream infection ($N = 25$)

Variable	No. (%) or median (range)
Time onset of infection from hospital admission (days)	7 (4–12)
Peripheral venous catheter rank	
First	11 (44)
Second	3 (12)
Third	2 (8)
Fourth or more	5 (20)
Unknown	4 (16)
Local complications	
Phlebitis	20 (80)
Pus	2 (8)
Local inflammation	3 (12)
No. of positive blood cultures	2 (1–4)
Bacterial species involved	
Staphylococcus aureus	16 (64)
Staphylococcus epidermidis	6 (24)
Enterococcus faecalis	1 (4)
Proteus mirabilis	1 (4)
Candida glabrata	1 (4)
Central venous access device placement for antibiotic administration	5 (20)
Total duration of antimicrobial therapy[a] (days)	14 (7–20)
Antimicrobial therapy continued after hospital discharge	5 (8)
At home hospitalization	2 (8)
At home without home hospitalization	2 (8)
After transfer to another care facility	1 (4)

[a] One patient received no antimicrobial therapy.

Table III
Investigations performed in connection with peripheral venous catheter-related bloodstream infection

Investigation	No. (%)
Cardiac ultrasound[a]	14 (48)
Body CT[b]	4 (16)
Body PET–CT[b]	4 (16)
Vascular Doppler	2 (8)
Dental panoramic	1 (4)

[a] Two patients had two cardiac ultrasounds.
[b] Three patients had both body computed tomography (CT) scan and body positron emission tomography (PET)–CT scan.

Table IV
Secondary complications due to peripheral venous catheter-related bloodstream infection

Complication	*N* (%)
Spondylodiscitis[a]	1 (4)
Sepsis requiring ICU admission[a]	1 (4)
Mitral valve endocarditis	1 (4)
Deep pre-sacral abscess	1 (4)
Death[b]	6 (24)

ICU, intensive care unit.
[a] Occurred in the same patient.
[b] One death was directly imputed to the catheter-related bloodstream infection.

patient who met all matching criteria could not be identified. This patient was admitted to the ICU because of the severity of infection and subsequently developed spondylodiscitis, which led to a prolonged hospital stay. The length of stay cost was estimated at €33,400. The other two cases were hospitalized during the first quarter of 2020. Their length of stay was 11 and 45 days and both died. Following a merger between establishments, the hospital does not have the costs per hospitalization. For the remaining 22 cases, we identified 204 controls with all matching criteria. The number of controls per case ranged from 1 to 53. The median (IQR) number of controls per case was 5 (2–13). Their main characteristics were similar to cases (Supplementary Table S3). Only one control (0.5%) died during his hospital stay compared with six cases (24%, $P < 0.0001$).

Median and individual cost comparison between cases and controls are shown in Table V and Supplementary Table S4, respectively. Median (IQR) hospital stay costs were €11,597 (8,479–23,759) for cases and €6,789 (4,019–10,764) for controls, leading to median additional costs of €5,587. This increase in costs was mainly related not only to increased length of hospital stay, but also to increased number of imaging and/or laboratory tests and medical consumables used.

Discussion

This retrospective study of nearly 10,000 patients hospitalized in a medical ward after visiting our emergency department identified 25 cases of PVC-related BSI, which represents 0.2% of the population studied. PVCs placed in the emergency department were involved in half of the cases. *S. aureus* was responsible for two-thirds of infections. Infection occurrence was followed by serious complications, increased length of hospital stays and probably deaths. The median cost of one infectious episode was estimated at €5,587.

Little evidence is available on the incidence and costs of PVC-related BSI in French medical wards complying with all current recommendations for infection prevention. The retrospective design of the study was justified because of the low number of PVC-related BSIs, representing herein about ten cases in medical wards per year on average. In fact, a prospective study would have required much more time and would have mobilized much greater human and financial resources without major gain to be expected, supported by ease to access digital patient files containing all patient and PVC information needed to categorize cases reliably. Inclusions were stopped at the beginning of the COVID era to avoid practice bias associated with the pandemic. All patient records with at least one positive blood culture were reviewed by two independent reviewers, and suspected cases identified by at least one of the reviewers were adjudicated by all three experts. Only cases with unanimous opinion were considered.

Incidence of PVC-related BSI in our medical patients was low, around 0.2%. This value is consistent with a systematic review of the literature published in 2017, which reported incidence of 0.18% among 63 studies with a total of 85,063 PVCs [9]. Another prospective multicentre study published in the same year reported an incidence of 0.16% PVC-related BSIs, or 1.6 PVC-related BSIs per 1000 admissions [18]. This relatively low incidence should be interpreted in light of the large number of PVCs used. Hence, in absolute value, the number of BSIs due to PVCs is similar to or even greater than with central venous catheters. It is therefore necessary to remind all caregivers of the importance of adhering to good practice rules not only when placing and caring for PVCs, but also with regard to use of the most effective materials to prevent the risk of infection [19,20].

Catheters placed in the emergency department were involved in half of the cases. PVC insertion in the emergency department is a well-known risk factor for infection [21]. Although the institutional protocol for the management of PVCs was available in the emergency department, the high workload combined with the rapid turnover of nurses prevented its systematic implementation. Replacement of any

Table V
Overall and per-item costs (in €)

Item	Cases ($N = 22$)	Controls ($N = 204$)	Difference
Overall	11,597 (8479–23,759)	6789 (4019–10,764)	5587
Medical consumables	540 (339–1131)	296 (165–370)	190
Laboratory	498 (405–1187)	225 (117–455)	225
Radiology	176 (1000–392)	93 (31–278)	86
Cardiac ultrasound	123 (28–218)	51 (0–219)	86
Vascular ultrasound	43 (0–63)	0 (0–32)	24

Data are presented as median (interquartile range).
Cases were defined as patients having developed a peripheral venous catheter-related bloodstream infection (PVC-related BSI) when controls (identified in 22 out of 25 cases) were case-matched patients who had not developed PVC-related BSI. Number of controls per case ranged from 1 to 53.

PVC placed in the emergency department should remain the rule once a patient's clinical condition has become stable.

Staphylococcus aureus was the most common micro-organism involved in PVC-related BSI, which is consistent with the findings of a one-year study conducted in 14 Spanish internal medicine departments [18]. By contrast, *S. aureus* was responsible for only 17% of 62 PVC-related BSIs in a five-year retrospective study conducted in two Japanese university hospitals [22]. Catheter insertion in an emergency department could be assumed as an additional risk factor for infection with this micro-organism, as reported in a cohort study of patients hospitalized from July 2005 through March 2008 in an American tertiary care teaching hospital [21]. The inclusion of more patients with coagulase-negative staphylococci blood cultures, rightly or wrongly, could also explain these differences.

All patients with PVC-related BSI had local complications such as phlebitis, pus, or local inflammation, although few patients had ultrasound. This observation was also reported in the previously cited Japanese study. Phlebitis was diagnosed in 63% of the patients, but only 28% of them received ultrasound [22]. In the same study, no secondary dissemination was found, probably because of a large number of missing data. In the present study, 12% of patients with PVC-related BSI had septic metastasis, a value similar to the 14% reported in the Spanish prospective study [18]. Septic metastasis included one case of mitral valve endocarditis and one case of spondylodiscitis requiring admission to ICU for severe sepsis. Lastly, one patient developed pre-sacral abscess three months after initial catheter infection and required hospital readmission for drainage. The high incidence and severity of these secondary complications of PVC-related BSI warrants implementation of any measure able to prevent PVC-related BSI occurrence. Interestingly, *S. aureus* was the micro-organism responsible in all these cases.

All but one patient with PVC-related BSI received a prolonged course of antibiotics, with a median duration of 14 days, which is consistent with the median duration of 19 days in the US cohort study [21]. Five patients required a central venous catheter for treatment. The morbidity of central vascular access is well known and should not be underestimated [23]. Similarly, the administration of prolonged antibiotic treatment promotes selection of antibiotic-resistant micro-organisms. Infections due to antibiotic-resistant micro-organisms lead to higher treatment failure and medical costs, prolonged hospital stays, and increased mortality [24].

The length of hospital stay was longer in cases (median: 21 days) than in controls (median: 13 days). This may be explained by the occurrence of serious complications and by the need for prolonged antibiotic treatment. Six (24%) cases in our cohort died within 45 days of infection onset. BSI accountability on mortality is difficult to collect retrospectively. In at least one case, death may be clearly attributable to the occurrence of infection. In the large one-year Spanish cohort study in 14 Spanish internal medicine departments, crude and attributable mortality rates were 12.9% and 5.7% respectively. Older and more vulnerable patients could explain the higher crude mortality in the present cohort.

As the University Hospital of Poitiers participates in the national cost database for hospital stays, costs for each patient hospital stay could be estimated. To better estimate average hospital stay cost in controls, we included all controls with all matching criteria. PVC-related BSI costs were obtained for each case by the difference between costs of hospital stay of the cases and median costs of hospital stay of corresponding controls. This amount represents the extra costs related to infection occurrence.

Direct costs of PVC-related BSI were estimated at €5,587 per episode. It is difficult to compare costs attributable to PVC-related BSI across countries as the methods of calculating hospitalization costs depend on the healthcare system. Impact of PVC-related BSI on patient death and on selection of bacterial resistance could not be taken into account. An analysis of a US hospital discharge database of nearly 600,000 admissions between 2013 and 2015 reported for patients with PVC complications (mostly infections, but also thrombophlebitis and extravasation) an average increase in hospital costs of $3,886 per episode [25]. This increase was explained by an average increase in length of stay of 50% and a doubling of the risk of admission to the ICU. Finally, the risk of death was multiplied by 5, rising from 0.7% in patients without complication to 3.6% in patients with complication.

The present study has limitations and its results should be interpreted with caution. First, the study design is retrospective. Nevertheless, the availability of numerous clinical and biological data thanks to the digitalization of patient files, the use of robust criteria, and the classification of cases by three experts enabled the acquisition of reliable data. Second, the study was conducted in a single French hospital: further studies are needed to confirm the generalizability of our findings. Third, only 25 cases of infection were identified, representing the low target value of expected cases. The COVID epidemic did not allow inclusion of patients admitted from March 2020 onwards, and, prior to 2018, not all departments in our hospital were digitalized. Nevertheless, the findings are consistent with the available literature. Fourthly, out of the 25 cases, only 22 could be included in the cost analysis. Even if the method chosen for estimating extra costs is based on a national method and is performed from the hospital's point of view, we believe that they are underestimated. First, the reimbursement of daily costs decreases as the length of stay increases. Thereby, the increased length of stay induced by the infection, which represents the main item of expenditure, is not as well compensated financially. Second, the large number of early deaths following infection reduced the impact on increased length of stay, and therefore the potential loss of income. Third, impact of infection on death and of antibiotic use on bacterial resistance could not be taken into account. Last, cost of secondary septic disseminations managed in hospitals other than the University Hospital of Poitiers could not be identified and then included in the analysis.

Our study also has strengths. First, it was conducted in a hospital sharing a single hospital-wide protocol for catheter placement and maintenance, which is based on the latest recommendations and allows for standardization of care practices across units. The retrospective nature of the study avoided external intervention in the wards, and therefore provided real-life evidence. Whereas the method used for cost estimation might seem open to question, it nevertheless corresponds to the funding received by hospitals when PVC-related BSIs occur. It also enables better identification of costs related to the infection in addition to the costs related to the disease that caused patient admission.

In conclusion, even though the risk of developing PVC-related BSI in patients admitted to medical wards may seem

low, it must be weighed against the number of PVCs used worldwide. Complications of PVC-related BSI are frequent and severe, and the associated mortality remains high. In addition, they increase healthcare costs and may be conducive to the selection of antibiotic-resistant bacteria. The financial resources used to treat these complications could be better spent on prevention, including the use of high-quality materials and technologies, and improved training of healthcare providers.

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Conflict of interest statement
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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jhin.2023.02.012.

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