Increased Peripheral Venous Catheter Bloodstream Infections during COVID-19 Pandemic, Switzerland

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Studies suggest that central venous catheter bloodstream infections (BSIs) increased during the COVID-19 pandemic. We investigated catheter-related BSIs in Switzerland and found peripheral venous catheter (PVC) BSI incidence increased during 2021–2022 compared with 2020. These findings should raise awareness of PVC-associated BSIs and prompt inclusion of PVC BSIs in surveillance systems.

Peripheral intravenous catheters (PVCs) and central venous catheters (CVCs) are frequently used in hospitalized patients. Estimates from global device sales illustrated that ≈1.2 billion PVCs are used worldwide annually (*1*,*2*). PVC-related complications include phlebitis, hematoma, and extravasation (*3*,*4*). PVC-associated bloodstream infections (BSIs) often are disregarded in surveillance systems because of low incidence (*5*,*6*). However, because PVCs are widely used in hospitalized patients, the burden of PVC-associated or related BSIs might still be substantial. In contrast, only 10% of acute care inpatients have a CVC inserted (*7*), but the incidence of BSIs associated with CVCs is higher than that for PVCs, likely because infection prevention strategies mostly focus on CVCs.

Several studies have shown that intravascular catheter infections increased during the COVID-19 pandemic (*8*–*11*). Those studies mainly focused on BSIs associated with CVCs. COVID-19 might have substantially affected the frequency of PVC infections, but published reports are lacking. To assess the incidence of BSIs associated with or related to intravenous catheters, we used a large prospective database to study BSIs by catheter type during the COVID-19 pandemic in Switzerland.

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The Study

We performed a cohort study at Geneva University Hospitals (HUG), a large network of tertiary care centers in Switzerland. HUG includes 5 rehabilitation or palliative care sites and 1 acute care, 1 geriatric, 1 pediatric, 1 gynecology-obstetrics, and 1 psychiatric site. HUG has ≈2,100 beds and receives 60,000 hospital admissions per year.

We included all patients hospitalized during January 1, 2020–December 31, 2022. All hospital-acquired BSIs during that timeframe were investigated as part of prospective hospital-wide surveillance, which has been conducted for >25 years by the HUG infection control program. We limited the analysis to catheter-related or -associated BSIs (CRABSIs), comprising catheter-related BSI (CRBSI) and catheter-associated BSI (CABSI). We classified CRABSI that were attributed to PVC, short-term CVC, and long-term CVC. The infection control program routinely collects patient data from CRABSI, including onset date, age, sex, ward of acquisition, catheter type, and microorganism identified.

The primary outcomes (i.e., CRABSI) were based on European Centre for Disease Prevention and Control definitions (*12*). A CRBSI required a positive blood culture ≤48 hours after catheter removal and

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the same microorganism isolated from a quantitative catheter tip culture or the same microorganism isolated in a culture from pus collected from a catheter site (Appendix, https://wwwnc.cdc.gov/EID/article/30/1/23-0183-App1.pdf). A CABSI required a positive blood culture occurring from time of insertion until 48 hours after catheter removal, resolution of symptoms within 48 hours after catheter removal, and no other infectious focus. We also tracked details of COVID-19 infections reported in the hospital system (Appendix).

We used patient-days as the main denominator, which we extracted from the electronic record system. We used a 5-step statistical plan. First, we determined the total monthly incidence of CRABSI, and CRABSI attributed to PVC, short-term CVC, and long-term CVC per 1,000 patient-days (Figure 1). Second, we evaluated incidence rate ratios (IRRs) for intravascular catheter infections stratified for catheter type for 2021 and 2022 by segmented Poisson regression models using aggregated monthly data and used 2020 as the referent and patient-days as the offset. We tested overdispersion by using the likelihood ratio test and subsequently fit a negative binomial model, if required. Third, we compared patient and microbiologic characteristics of CRABSI attributed to PVC between the different periods using χ^2 test for categorical variables and Kruskal-Wallis test for continuous variables. Fourth, we determined the number of PVCs and PVCs in situ >4 days inserted per month. Fifth, we performed a sensitivity analysis by using catheter-days as a denominator for CRABSI attributed to PVC and CVC.

We used SAS version 9.4 (SAS Institute, Inc., https://www.sas.com) to perform all analyses and considered p<0.05 statistically significant. This analysis complies with STROBE guidelines for observational studies (*13*).

During the study period, a total of 179,463 patients were hospitalized at HUG, corresponding to 1,978,177 patient-days. We included 249 CRABSI episodes. We observed 90 CRABSI attributed to PVC, 94 attributed to short-term CVC, 74 attributed to long-term CVC, and 9 cases were possibly attributable to >1 intravascular catheter. Overall, the median age of patients with a CRABSI was 61 (interquartile range [IQR] 47–73) years; 62.3% (n = 155) were male and 37.7% (n = 94) were female. Most (37.8%, n = 94) CRABSI were caused by coagulase-negative staphylococci (Appendix Table 1).

CRABSI incidence remained stable during the study period, but we observed peaks in CRABSI attributed to short-term and long-term CVC during November 2021–January 2022 (Appendix Figure 1). Of note, incidence of CRABSI attributed to PVC increased during late 2021 and in 2022. Similarly, the proportion of CRABSI attributed to PVC among all intravascular catheter infections increased during late 2021 and in 2022 (Figure 1).

Overall, compared with 2020, IRRs for CRABSI did not significantly increase in 2021 (IRR 1.24, 95% CI 0.91–1.71; p = 0.18) and 2022 (IRR 1.19, 95% CI 0.87–1.64; p = 0.27) (Figure 2; Appendix Table 2). By contrast, rates of CRABSI attributed to PVC significantly increased during 2021 (IRR 2.08, 95% CI 1.14–3.78; p = 0.02) and 2022 (IRR 3.23, 95% CI 1.85–5.65; p<0.01) compared with 2020. Rates of CRABSI attributed to short-term and long-term CVC did not show statistically significant changes (Figure 2; Appendix Table 2).

Among patients with CRABSI attributed to PVC, we did not observe statistically significant

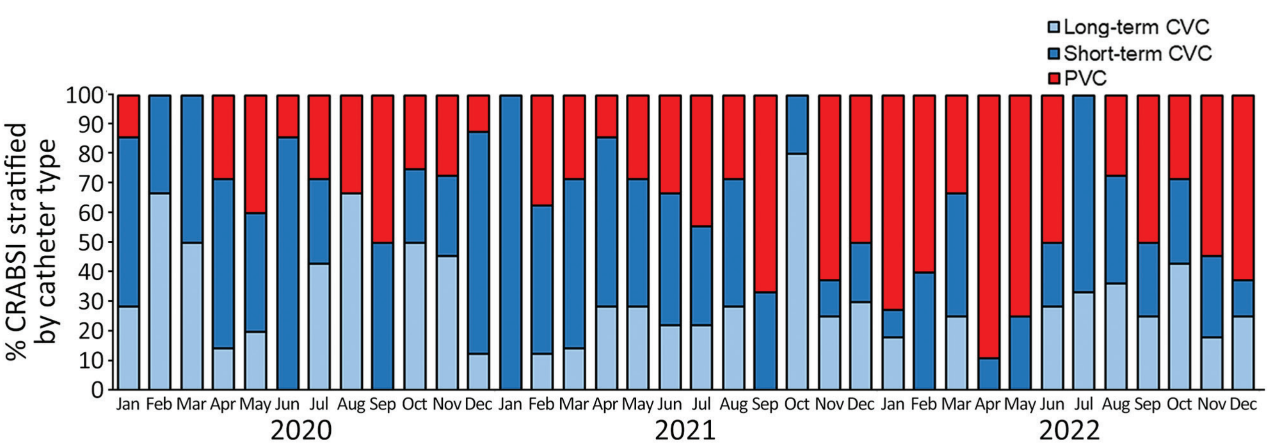

Figure 1. Percentage of intravascular catheter infections stratified by catheter type in study of intravascular catheter bloodstream infections during the COVID-19 pandemic, Switzerland, January 1, 2020–December 31, 2022. CRABSI, catheter-related or -associated bloodstream infections; CVC, central venous catheter; PVC, peripheral venous catheter.

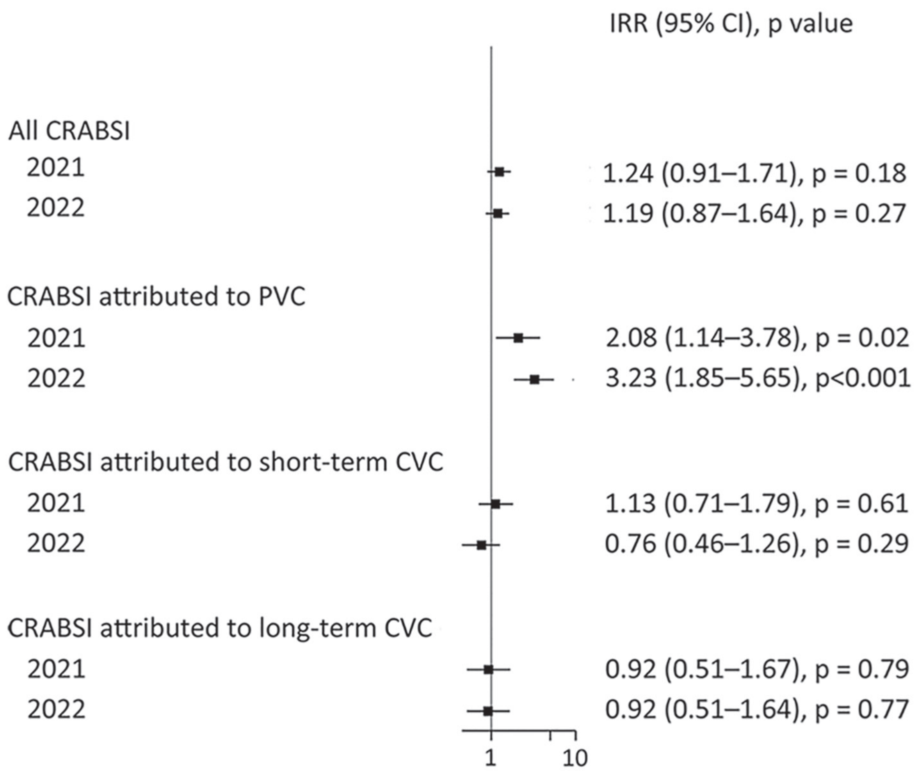

Figure 2. Incidence rate ratios per 1,000 patient days in a study of intravascular catheter bloodstream infections during the COVID-19 pandemic, Switzerland, January 1, 2020–December 31, 2022. Squares indicate IRRs, bars indicate 95% CIs. Patient-days were used as the denominator; 2020 rates were used as the referent. BSI, bloodstream infection; CRABSI, catheter related or associated bloodstream infections; CVC, central venous catheter; IRR, incidence rate ratio; PVC, peripheral venous catheter.

differences for sex, age, ward of acquisition, or microorganism distribution (Appendix Table 1). We observed similar results for short-term and long-term CVC (Appendix Table 1). Furthermore, the monthly number of CVCs and PVCs inserted, and PVCs in situ >96 hours did not change over time (Appendix Table 3, Figures 2, 3). A sensitivity analysis using catheter-days as a denominator yielded similar results (Appendix Figure 4).

Conclusions

This study showed that CRABSI attributed to PVC increased during the 2021–2022 compared with 2020. Studies in different countries showed that CVC-related BSIs increased during the COVID-19 pandemic (*10*,*11*), but no data on PVC-related infections are available.

Several hypotheses might explain these findings. First, ward of acquisition and microorganism distributions from 2020–2022 did not substantially change among PVC-related BSIs. Nevertheless, we observed a nonsignificant increase of PVC-attributed CRABSI due to coagulase-negative staphylococci in surgery wards in 2022. Moreover, we did not observe a significant increase of blood culture contaminations during 2021–2022 compared with 2020 (*14*). Second, according to our institutional recommendations, PVCs should be routinely changed every 4 days. We did not observe an increase of PVCs inserted for >96 h, suggesting adequate compliance to that preventive measure (Appendix). Recent unpublished data from France showed similar alarming results in the surveillance system of devices associated infections (*15*).

Our study's first limitation is that the study was single-center, limiting the generalizability of the results; however, HUG comprises several different sites, thus increasing the diversity of the patient population. Moreover, our data cannot be generalized to centers that routinely use midline catheters or that routinely use other infection control strategies, such as chlorhexidine-gluconate bathing post-CVC insertion or use of impregnated dressings. Second, we did not include confounders such as site of insertion, emergent versus elective insertions, immunocompromised states, chronic illnesses, body mass index, and nurse-to-patient ratio in our analysis. Third, our primary outcome, CRABSI, did not include pulmonary arterial, peripheral arterial, and umbilical arterial catheter infections.

In conclusion, our findings show that CRABSI attributed to PVC significantly increased during 2021–2022 in HUG. The observed increasing incidence of CRABSI attributed to PVC should raise awareness and warrants inclusion of PVC-related BSIs in national surveillance systems.

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References

1. Zingg W, Pittet D. Peripheral venous catheters: an under-evaluated problem. Int J Antimicrob Agents. 2009; 34:S38–42. https://doi.org/10.1016/S0924-8579(09)70565-5
2. PR Newswire. Global peripheral I.V. catheter market 2014–2018 [cited 2022 Jul 17]. https://www.prnewswire.com/news-releases/global-peripheral-iv-catheter-market-2014-2018-257019061.html
3. Hadaway L. Short peripheral intravenous catheters and infections. J Infus Nurs. 2012;35:230–40. https://doi.org/10.1097/NAN.0b013e31825af099
4. Buetti N, Abbas M, Pittet D, Chraiti MN, Sauvan V, De Kraker MEA, et al. Lower risk of peripheral venous catheter-related bloodstream infection by hand insertion. Antimicrob Resist Infect Control. 2022;11:80. https://doi.org/10.1186/s13756-022-01117-8
5. Buetti N, Abbas M, Pittet D, de Kraker MEA, Teixeira D, Chraiti MN, et al. Comparison of routine replacement with clinically indicated replacement of peripheral intravenous catheters. JAMA Intern Med. 2021;181:1471–8. https://doi.org/10.1001/jamainternmed.2021.5345
6. Mermel LA. Short-term peripheral venous catheter–related bloodstream infections: a systematic review. Clin Infect Dis. 2017;65:1757–62. https://doi.org/10.1093/cid/cix562
7. Zingg W, Metsini A, Balmelli C, Neofytos D, Behnke M, Gardiol C, et al. National point prevalence survey on healthcare-associated infections in acute care hospitals, Switzerland, 2017. Euro Surveill. 2019;24:1800603. https://doi.org/10.2807/1560-7917.ES.2019.24.32.1800603
8. Porto APM, Borges IC, Buss L, Machado A, Bassetti BR, Cocentino B, et al. Healthcare-associated infections on the ICU in 21 Brazilian hospitals during the early months of the COVID-19 pandemic: an ecological study. Infect Control Hosp Epidemiol. 2023;44:284–90. https://doi.org/10.1017/ice.2022.65
9. Rosenthal VD, Myatra SN, Divatia JV, Biswas S, Shrivastava A, Al-Ruzzieh MA, et al. The impact of COVID-19 on health care-associated infections in intensive care units in low- and middle-income countries: International Nosocomial Infection Control Consortium (INICC) findings. Int J Infect Dis. 2022;118:83–8. https://doi.org/10.1016/j.ijid.2022.02.041
10. Baker MA, Sands KE, Huang SS, Kleinman K, Septimus EJ, Varma N, et al.; CDC Prevention Epicenters Program. The impact of coronavirus disease 2019 (COVID-19) on healthcare-associated infections. Clin Infect Dis. 2022;74:1748–54. https://doi.org/10.1093/cid/ciab688
11. Weiner-Lastinger LM, Pattabiraman V, Konnor RY, Patel PR, Wong E, Xu SY, et al. The impact of coronavirus disease 2019 (COVID-19) on healthcare-associated infections in 2020: a summary of data reported to the National Healthcare Safety Network. Infect Control Hosp Epidemiol. 2022;43:12–25. https://doi.org/10.1017/ice.2021.362
12. European Centre for Disease Prevention and Control. Surveillance of healthcare-associated infections and prevention indicators in European intensive care units 2017 [cited 2017 May 5]. https://www.ecdc.europa.eu/sites/default/files/documents/HAI-Net-ICU-protocol-v2.2_0.pdf
13. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP; STROBE Initiative. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. BMJ. 2007;335:806–8. https://doi.org/10.1136/bmj.39335.541782.AD
14. Chraiti M-N, Abbass M, Nguyen M, Zanella M-C, Catho G, Bosetti D, et al. Contamination of blood cultures before and during COVID-19 in a large tertiary-care center in Switzerland. In: Abstracts of the 7th International Conference on Prevention and Infection Control 2023; Geneva; 2023 Sep 12–15. Abstract P476. https://doi.org/10.1186/s13756-023-01276-2
15. Van der Mee-Marquet N, Goube F, Gimenes R, Valentin AS. Surveillance of infections linked to invasive devices, developments 2019–2022 [in French] [cited 2022 October 18]. https://www.santepubliquefrance.fr

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Appendix

Included Intravascular Catheters

Intravascular catheters included in this study were peripheral vascular catheters (PVCs), and short-term and long-term central venous catheters (CVCs). Long-term CVC were tunneled catheters, hemodialysis catheters, totally implanted ports and peripherally inserted central catheter (PICC) lines. No midline catheters are inserted at HUG.

Definitions

For more than 25 years, the University of Geneva Hospitals system has performed a hospital-wide prospective surveillance of all healthcare-associated blood stream infections (BSIs). For each hospital-associated BSI episode, data on source of infection, and clinical and microbiological characteristics are routinely collected by the infection prevention and control (IPC) team. In brief, each new positive blood culture result (even without definite microbiological results; i.e., prospectively) is routinely communicated from the central microbiology laboratory to IPC team members during working days (i.e., each potential healthcare-associated positive blood culture result is assigned to a member of the IPC team), who prospectively follow up and investigate sources of healthcare-associated episodes. Criteria for investigating episodes were: 1) occurrence more than 48 hours after hospital admission or previous hospitalization in the last 10 days, 2) surgery in the last 30 (nonimplant surgery) or 90 (implant surgery) days, 3) occurrence in neonatal units, 4) positive blood culture results in patient obstetric wards, and 5) positive blood culture results in hemodialysis and onco-hematologic outpatients.

Classification of CVC- and PVC-related or -associated BSIs (i.e., CRABSI) were based on the European Centre for Disease Prevention and Control (ECDC) definitions (*1*). A catheter-related BSI (CRBSI) required a positive blood culture occurring from catheter insertion until 48h after catheter removal, with the same microorganism as isolated from a quantitative catheter tip culture $\geq 10^3$ CFU/ml (or semiquantitative catheter culture >15 colony forming unit) or a positive exit-site culture from pus. A catheter-associated BSI (CABSI) required a positive blood culture occurring from day of insertion until 48h after catheter removal, the resolution of symptoms in 48h after catheter removal and no other infectious focus. Common skin contaminants were included only if detected in at least two blood cultures within 48h and the patient had at least one sign or symptom of infection (chills, hypotension, or fever [>38.0°C]). Common skin contaminants were defined according to the National Healthcare Safety Network (NHSN) official list (e.g., *Corynebacterium* spp, *Bacillus* spp, *Micrococcus* spp, coagulase-negative staphylococci [CoNS], and *Propionibacterium* spp).

In comparison with the ECDC definitions that were applied in this study for the classification of CVC- and PVC-related or -associated BSIs (i.e., CRABSI), IDSA definitions consider only catheter tip cultures and differential time to positivity (DTP) for catheter-related infections (*2*), and US Centers for Disease Control and Prevention (CDC) CLABSI definitions do not consider catheter tip cultures and DTP (*3*,*4*).

COVID-19 Situation

In March 2020, HUG was transformed to accommodate the increase in COVID-19 patients (e.g., several units were transformed into COVID-19 dedicated units). The COVID-19 pandemic dramatically changed the patient population (non–COVID-19 were diverted to other "non–COVID-19" hospitals in the area) and influenced care procedures (e.g., healthcare workers [HCWs] were reallocated to different wards). Of note, infection prevention measures related to catheters remained similar during the different periods analyzed.

The COVID-19 hospitalizations were extracted using the Swiss hospital sentinel surveillance system (Hospital Based Surveillance CH-SUR), an ongoing surveillance system since the beginning of the pandemic. The prospective surveillance of BSIs was continued even during the pandemic, from 1st January 2020 to 30th September 2022.

Infection Prevention Procedures

Institutional recommendations for PVC insertion and care were the following: (i) alcohol-containing 2% chlorhexidine-gluconate (CHG) was used for skin antisepsis at catheter insertion and during dressing changes; (ii) the selection of site of insertion was left to the discretion of the healthcare workers caring for the patient; (iii) semipermeable transparent dressings were used for all PVCs and changed when clinically indicated. PVCs were routinely replaced every 4 days. Institutional recommendations for CVC insertion and care were the following: (i) maximal sterile barrier precaution; (ii) alcohol-containing 2% CHG was used for skin antisepsis but no CHG-bathing was applied; (iii) the selection of site of insertion and the utilization of ultrasound guidance was left to the HCWs; (iv) semipermeable transparent dressings without antiseptic impregnation were used for all CVCs; (v) no impregnated catheters were routinely used. Soiled, leaking, or wet dressings were immediately changed. Infection prevention measures did not change during the study period.

Ethics

The hospital-acquired BSI surveillance is part of a mandatory indicator surveillance at HUG and thus, is considered as quality assurance. Only pseudonymized data has been processed, and therefore ethical board approval for data re-use is not required.

Additional Hypotheses for the Main Results of the Study

First, peaks of CRABSI attributed to PVC incidence were not concomitant with peaks of hospitalizations due to SARS-CoV-2 infections during 2020 and 2021, thus suggesting that hospital overcrowding may not have played a major role for the occurrence of CRABSI attributed to PVC. Second, we could hypothesize that the lack of compliance to other preventive measures or hospital reorganization, increased workload, staff shortage/turnover, as well as a reduced educational activities may have contributed to our observations in 2021–2022.

References

1. European Centre for Disease Prevention and Control. Surveillance of healthcare-associated infections and prevention indicators in European intensive care units [cited 2017 May 5]. https://www.ecdc.europa.eu/sites/default/files/documents/HAI-Net-ICU-protocol-v2.2_0.pdf

2. Mermel LA, Allon M, Bouza E, Craven DE, Flynn P, O'Grady NP, et al. Clinical practice guidelines for the diagnosis and management of intravascular catheter-related infection: 2009 Update by the Infectious Diseases Society of America. Clin Infect Dis. 2009;49:1–45. PubMed https://doi.org/10.1086/599376

3. US Centers for Disease Control and Prevention. Chapter 4: bloodstream infection (BSI) event. Central line-associated bloodstream infection (CLABSI) and non-central line-associated bloodstream infection [cited 2022 October 18]. https://www.cdc.gov/nhsn/psc/bsi/index.html

4. Buetti N, Timsit JF. Management and prevention of central venous catheter–related infections in the ICU. Semin Respir Crit Care Med. 2019;40:508–23. PubMed https://doi.org/10.1055/s-0039-1693705

Appendix Table 1. Characteristics of patients and microbiology of CRABSI attributed to PVC, short-term CVC, and long-term CVC during COVID-19 pandemic, Switzerland*

Characteristics	2020	2021	2022	p value
CRABSI attributed to PVC, n = 90†	N = 14	N = 31	N = 45	
Sex				
M	10 (71.4)	22 (71)	26 (57.8)	0.42
F	4 (28.6)	9 (29)	19 (42.2)	
Median age, y (IQR)	75.5 (59–83)	66 (49–74)	69 (60–76)	0.13
Ward of acquisition‡				
Outpatient	0	0	0	0.48
ICU/emergency	2 (14.3)	8 (25.8)	4 (8.9)	
Medicine	5 (35.7)	9 (29)	14 (31.1)	
Geriatrics	3 (21.4)	3 (9.7)	4 (8.9)	
Oncology	0	0	0	
Pediatrics/gynecology	0	0	0	
Surgery	4 (28.6)	8 (25.8)	18 (40)	
Other	0 (0)	3 (9.7)	5 (11.1)	
Microbiology				
CoNS	5 (35.7)	10 (32.3)	22 (48.9)	0.72
Staphylococcus aureus	3 (21.4)	6 (19.4)	7 (15.6)	
Enterobacterales	3 (21.4)	6 (19.4)	6 (13.3)	
Polymicrobial	1 (7.1)	5 (16.1)	8 (17.8)	
Other gram-negative	0 (0)	2 (6.5)	1 (2.2)	
Other gram-positive	1 (7.1)	1 (3.2)	0	
Fungi	1 (7.1)	1 (3.2)	1 (2.2)	
CRABSI attributed to short term CVC, n = 94§	N = 30	N = 37	N = 27	
Sex				
M	21 (70)	26 (70.3)	17 (63)	0.80
F	9 (30)	9 (29.7)	10 (37)	
Median age, y (IQR)	47 (0–65)	60 (50–67)	58 (53–65)	0.05
Ward of acquisition‡				
Outpatient	0 (0)	1 (2.7)	3 (11.1)	0.84
ICU/emergency	5 (16.7)	12 (32.4)	8 (29.6)	
Medicine	1 (3.3)	6 (16.2)	1 (3.7)	
Geriatrics	1 (3.3)	1 (2.7)	1 (3.7)	
Oncology	8 (26.7)	9 (24.3)	8 (29.6)	

Characteristics	2020	2021	2022	p value
Pediatrics/gynecology	12 (40)	2 (5.4)	4 (14.8)	
Surgery	2 (6.7)	5 (13.5)	2 (7.4)	
Other	1 (3.3)	1 (2.7)	0	
Microbiology				
CoNS	14 (46.7)	10 (27)	13 (48.1)	0.81
S. aureus	4 (13.3)	5 (13.5)	4 (14.8)	
Enterobacterales	4 (13.3)	4 (10.8)	2 (7.4)	
Polymicrobial	1 (3.3)	4 (10.8)	1 (3.7)	
Other Gram-negative	1 (3.3)	4 (10.8)	2 (7.4)	
Other Gram-positive	6 (20)	9 (24.3)	4 (14.8)	
Fungi	0 (0)	1 (2.7)	1 (3.7)	
CRABSI attributed to long term CVC, n = 74¶	N = 28	N = 23	N = 23	
Sex				
M	17 (60.7)	14 (60.9)	9 (39.1)	0.22
F	9 (29.3)	9 (29.1)	14 (60.8)	
Median age, y (IQR)	58.5 (46–70)	57 (31–65)	69 (45–77)	0.12
Ward of acquisition‡				
Outpatient	2 (7.1)	1 (4.3)	2 (8.7)	0.78
ICU/emergency	1 (3.6)	0 (0)	1 (4.3)	
Medicine	2 (7.1)	4 (17.4)	6 (26.1)	
Geriatrics	6 (21.4)	4 (17.4)	4 (17.4)	
Oncology	7 (25)	7 (30.4)	2 (8.7)	
Pediatrics/gynecology	3 (10.7)	3 (13)	1 (4.3)	
Surgery	5 (17.9)	2 (8.7)	4 (17.4)	
Other	2 (7.1)	2 (8.7)	3 (13)	
Microbiology				
CoNS	6 (21.4)	8 (34.8)	7 (30.4)	0.62
S. aureus	4 (14.3)	4 (17.4)	2 (8.7)	
Enterobacterales	6 (21.4)	4 (17.4)	6 (26.1)	
Polymicrobial	7 (25)	2 (8.7)	3 (13)	
Other gram-negative	0 (0)	2 (8.7)	0	
Other gram-positive	2 (7.1)	3 (13)	3 (13)	
Fungi	3 (10.7)	0 (0)	2 (8.7)	

*Values represent no. (%), except where indicated. BSI, bloodstream infection; CoNS, coagulase-negative staphylococci; CRABSI, catheter related/associated bloodstream infection; CRBSI, catheter-related BSI; CVC, central venous catheter; ICU, intensive care unit; PVC, peripheral venous catheter.
†Overall, we observed a total of 9 (10%) BSIs related to PVCs (CRBSI). Among CRABSI attributed to PVC, 14.3% (2/14) were related to PVCs during 2020, 3.2% (1/31) during 2021, and 13.3% (6/45) during 2022.
‡Wards of acquisition reported in this table belong to 1 of the 10 sites of Geneva University Hospitals, including 5 rehabilitation or palliative care sites, 1 acute care, 1 geriatric, 1 pediatric, 1 gynecology-obstetrics, and 1 psychiatry site.
§Overall, we observed a total of 57 (60.6%) BSIs related to short term CVCs (CRBSI). Among CRABSI attributed to short term CVC, 66.7% (20/30) were related to short term CVC during 2020, 54% (20/37) during 2021, and 63% (17/27) during 2022.
¶Overall, we observed a total of 54 (60.8%) BSIs related to long term CVCs (CRBSI). Among CRABSI attributed to long term CVC, 71.4% (20/28) were related to long term CVC during 2020, 47.8% (11/23) during 2021, and 60.9% (14/23) during 2022.

Appendix Table 2. Number of CRABSI, CRABSI attributed to PVC, short-term and long-term CVC, and patient-days, used for CRABSI incidence rate ratio calculations, Switzerland*

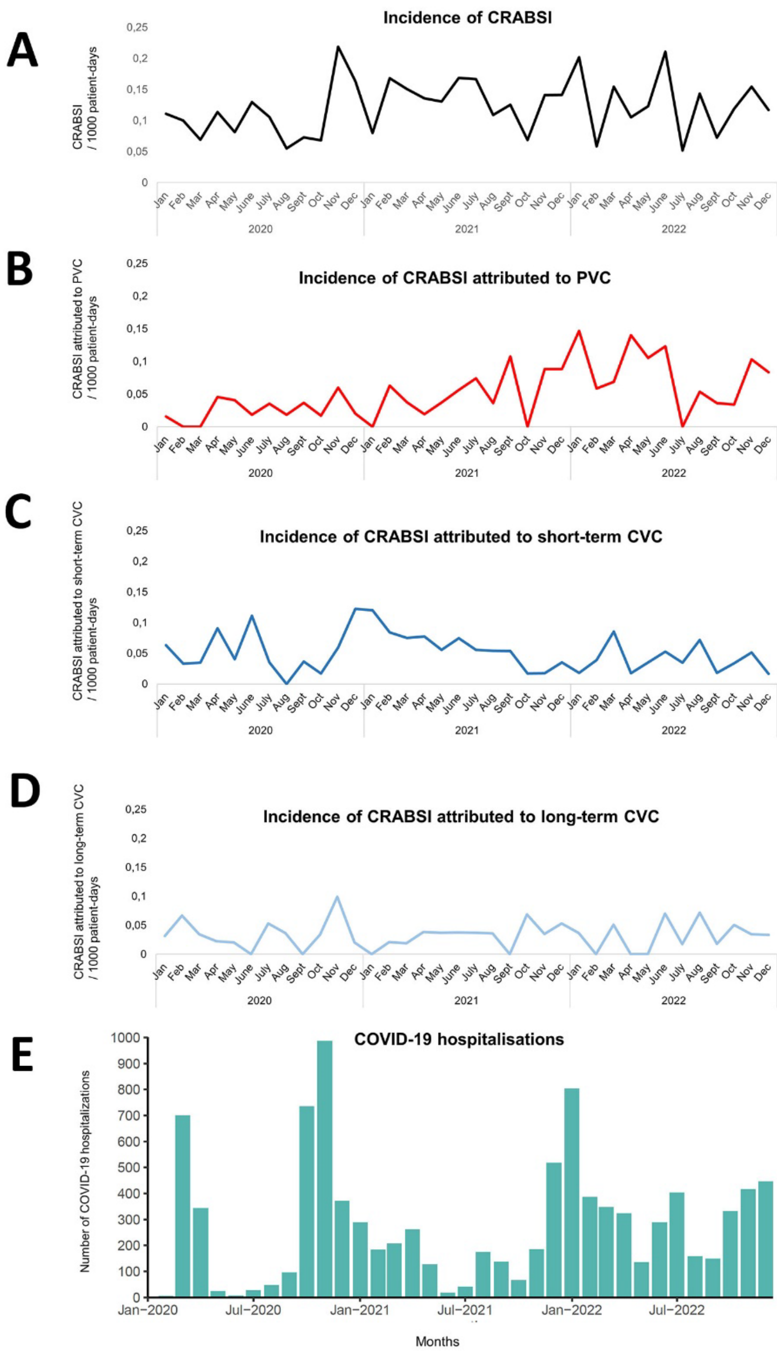
Year	Total no.†	No. attributed to PVC	No. attributed to short-term CVC	No. attributed to long-term CVC	Patient-days
2020	69	14	30	28	651,829
2021	85	31	37	23	645,666
2022	86	45	27	23	680,682

*BSI, bloodstream infection; CoNS, coagulase-negative staphylococci; CRABSI, catheter related/associated bloodstream infection; CVC, central venous catheter; PVC, peripheral venous catheter.
†The total number of CRABSI could be less than the sum of all CRABSI attributed to PVC, short-term CVC and long-term CVC. Nine cases were possibly attributable to >1 intravascular catheter.

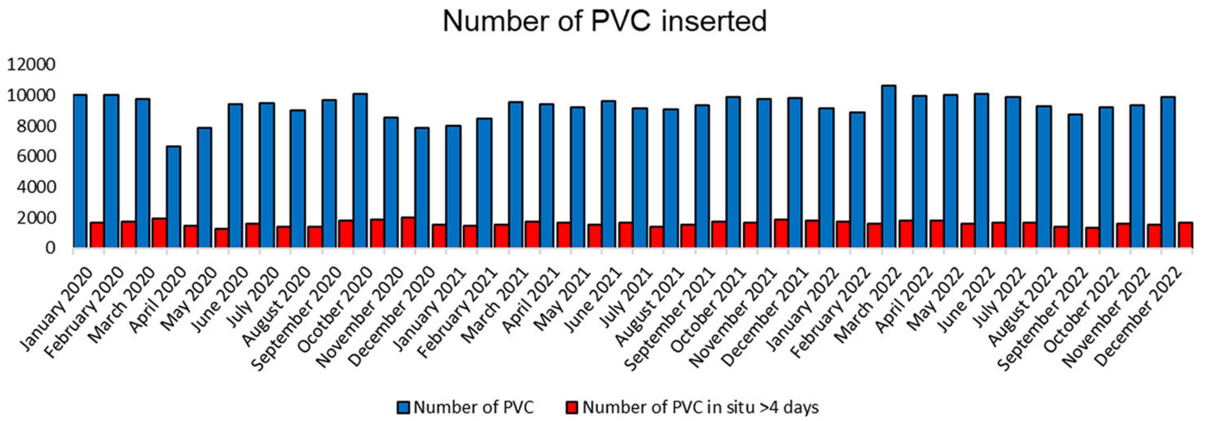
Appendix Table 3. Number of catheters placed per year in a study of increased peripheral venous catheter bloodstream infections during the COVID-19 pandemic, Switzerland*

Characteristics	2020	2021	2022
Total no. inserted	108,491	111,363	86,615
Dwell time >96 h	19,839 (18.3)	19,660 (17.7)	14,690 (17.0)
Dwell time >120 h	10,195 (9.4)	9,315 (8.4)	6,543 (7.6)

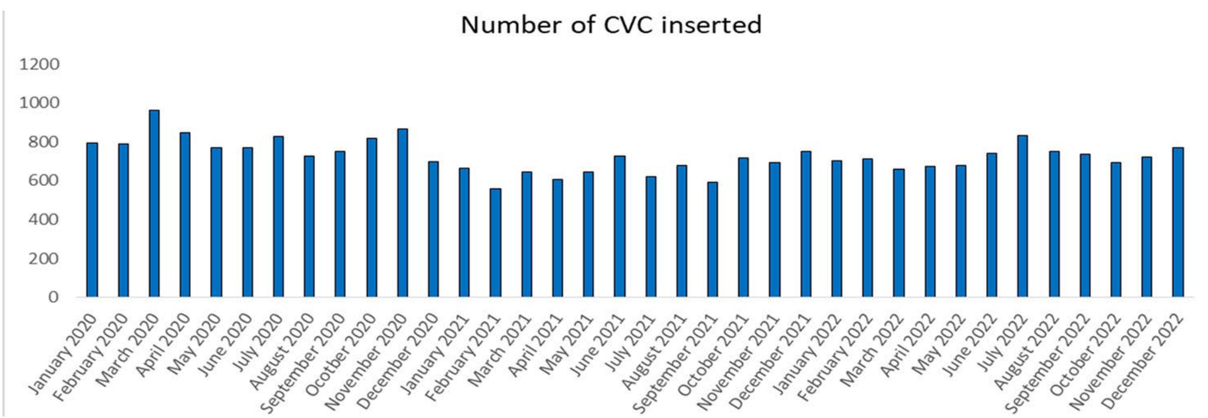
*Values represent no. (%)



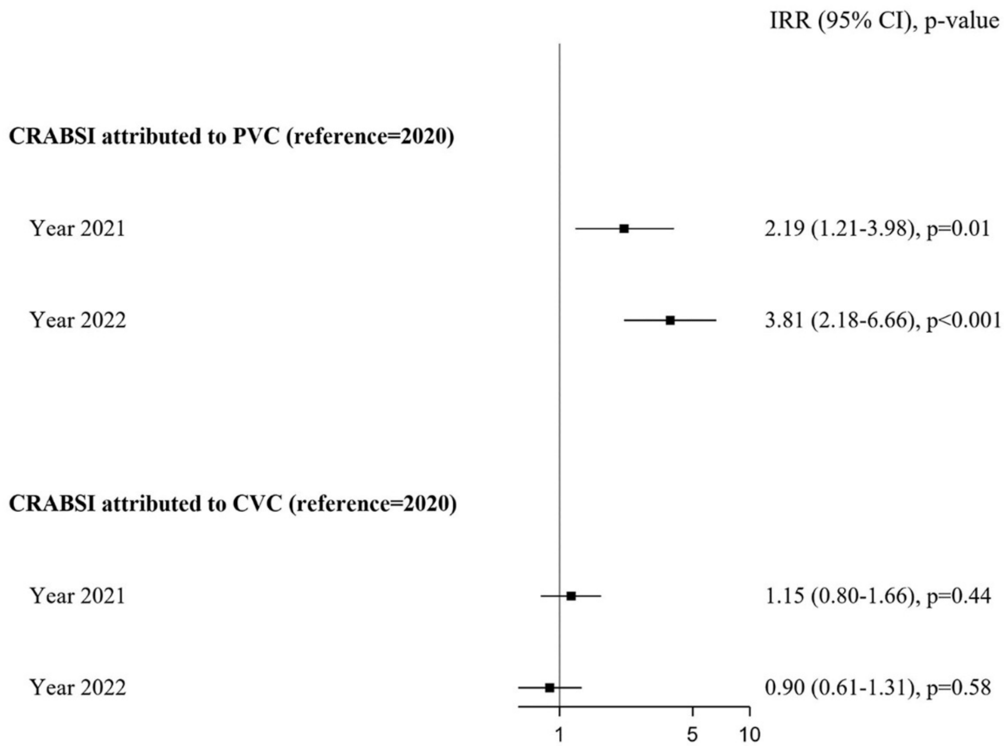
Appendix Figure 1. Monthly incidences of intravascular catheter bloodstream infections during the COVID-19 pandemic, Switzerland. A–D) Incidence of CRABSI per 1,000 patient-days; E) number of COVID-19 hospitalizations per month at Geneva University Hospitals, January 1, 2020–December 31, 2022. A) Overall CRABSI incidence; B) CRABSI incidence attributed to PVC; C) CRABSI incidence attributed to short-term CVC. D) CRABSI incidence attributed to long-term CVC. CRABSI, catheter related/associated bloodstream infection; CVC, central venous catheter; PVC, peripheral venous catheter.



Appendix Figure 2. Total number of inserted PVC in a study of intravascular catheter bloodstream infections during the COVID-19 pandemic, Switzerland, January 1, 2020–December 31, 2022. Graph shows total PVC inserted and number in situ >96 hours. PVC, peripheral venous catheter.



Appendix Figure 3. Total number of central venous catheters inserted per month in a study of intravascular catheter bloodstream infections during the COVID-19 pandemic, Switzerland, January 1, 2020–December 31, 2022. CVC, central venous catheter.



Appendix Figure 4. Incidence rate ratios for intravascular catheter infections, CRABSI attributed to PVC, and CRABSI attributed to CVC in a study of intravascular catheter bloodstream infections during the COVID-19 pandemic, Switzerland, January 1, 2020–December 31, 2022. Squares indicate IRR, bars indicate 95% CI. Short-term CVC and long-term CVC were considered together. Catheter-days were used as the denominator. CRABSI, catheter related/associated bloodstream infection; CVC, central venous catheter; IRR, incidence rate ratio; PVC, peripheral venous catheter.