
ARTICLE INFO

AUTHOR'S AFFILIATIONS

Medical Education Study Program,
Faculty of Medicine, Universitas
Hang Tuah¹

Pediatric Surgery Sub Department,
Surgery Department, Faculty of
Medicine, Universitas Hang Tuah²

Dermatology and Venereology
Department, Faculty of Medicine,
Universitas Hang Tuah³

Clinical Pathology Department,
Faculty of Medicine, Universitas
Hang Tuah⁴

CORRESPONDING AUTHOR

Verna Biutifasari

Faculty of Medicine, Universitas
Hang Tuah

E-mail:

biutifasari.verna@hangtuah.ac.id

Article history

Received 03-02-2026

Revised 06-08-2026

Accepted 29-09-2026

Available online

Please cite this article in APA 7th
edition style as:

Nissa, A. D., Prihartono, S., Violina,
D., Biutifasari, V., Setiawan, V., &
Nugraheni, P. A. (2026). Prolonged
central venous catheterization and
suspected bloodstream infection in
neonates: A NICU study. *Jurnal
Ilmiah Kedokteran Wijaya Kusuma*,
13(2), 150–160.

<https://doi.org/10.30742/jikw.v15i2.5211>

Prolonged Central Venous Catheterization and Suspected Bloodstream Infection in Neonates: A NICU Study

Artisyanti Dwi Nissa¹, Sapta Prihartono², Densy Violina³,
Verna Biutifasari⁴, Vendra Setiawan⁵, Pramita Anindya
Nugraheni^{6*}

Abstract

Background: Central venous catheterization is an important step for newborns in the NICU. Still, keeping the line in for too long can raise the chance of infection. One concern is a suspected bloodstream infection. These infections can make outcomes much worse for babies, including higher risk of death and serious illness. **Objective:** This study aimed to examine the association between prolonged central venous catheterization and suspected bloodstream infection in neonate patients. **Methods:** This retrospective cohort study included neonates admitted to the NICU of RSPAL dr. Ramelan Surabaya who underwent CVC placement from 2023-2025. Demographic, clinical, and laboratory data, including CVC duration and suspected CLABSI, were collected from medical records. The association between CVC duration and suspected CLABSI was analyzed using the Spearman and Fisher's exact test, with $p < 0.05$ considered statistically significant. **Result:** Data were obtained from 52 neonates with an average age of 4.885 ± 6.767 days and an average CVC placement duration/ICU stay of 15.15 ± 10.68 days; 3.7% of the neonates with a CVC had suspected bloodstream infection, and no significant difference was identified ($p = 1$) in the analysis performed using Fisher's exact test.

Conclusion:

There is no significant difference between prolonged central venous catheterization and suspected blood stream infection

Keywords: central line-associated bloodstream infection, neonate, central venous catheter, neonatal intensive care unit

Original Research Article

INTRODUCTION

Central venous catheters (CVCs) are essential in neonatal intensive care units (NICUs) for prolonged intravenous therapy, parenteral nutrition, and medication administration. However, CVC use increases the risk of bloodstream infection, particularly in neonates who are vulnerable because of immune immaturity, frequent invasive procedures, and prolonged hospitalization. (Erayman et al., 2026; National Healthcare Safety Network, 2025; World Health Organization, 2024). Prolonged catheter exposure may increase opportunities for microbial colonization, biofilm formation, and catheter manipulation. Recent studies have reported an association between longer catheter dwell time and central line-associated bloodstream infection (CLABSI) in neonates. (Perme, 2023; Selby et al., 2021).

One important and potentially modifiable factor related to bloodstream infection is the duration of central-line exposure. Prolonged catheterization may provide greater opportunity for microbial colonization, biofilm formation, and contamination during catheter manipulation. Recent evidence supports an association between longer catheter dwell time and bloodstream infection in neonates.(Buttera et al., 2025; Catho et al., 2023; Kochanowicz et al., 2022; Perme, 2023; Selby et al., 2021; Zheng et al., 2023). A retrospective study of infants admitted to level III NICU found that prolonged central-line dwell time was an independent risk factor for CLABSI, with the risk increasing with each additional day of catheter exposure. Similarly, a recent review reported that longer dwell times of umbilical venous and peripherally inserted central catheters were generally associated with increased infection risk, although the optimal duration for catheter removal remains uncertain(Jufan, 2024).

Neonates who require central venous catheters (CVCs) typically need more intensive and extended treatment.(Kartikeswar et al., 2023). The utilization of CVCs, particularly when complicated by catheter-related infections or prolonged exposure, is associated with systemic inflammatory responses that may correlate with adverse neonatal brain conditions, cognitive deficits, motor impairments, and long-term neurodevelopmental delays(Kartikeswar et al., 2023; Kochanowicz et al., 2022). Furthermore, CVC placement carries inherent mechanical risks; the small caliber of neonatal blood vessels presents a potential risk factor for vascular thrombosis, obstruction, leakage, and localized tissue damage.(Perme, 2023). The use of a 48-hour threshold in the present study provides a clinically relevant approach for evaluating early prolonged exposure to central venous access. Importantly, this threshold represents the exposure definition used in this study and should not be interpreted as equivalent to the formal CDC/NHSN CLABSI surveillance definition, which uses consecutive calendar days and specific laboratory and clinical criteria to identify central line-associated infections. (Bunn & Cornish, 2025)

This study aimed to examine the association between prolonged central venous catheterization and suspected bloodstream infection in neonate's patients who treated at the Neonatal Intensive Care Unit (NICU) of RSPAL dr. Ramelan Surabaya during the period 2023–2025.

MATERIALS AND METHODS

Participants and Data Collection

This retrospective cohort study included neonates admitted to the NICU of RSPAL dr. Ramelan Surabaya from 2023 to 2025. The inclusion criteria consisted of neonates with accessible demographic information who had an indwelling catheter in place for a minimum of 48 hours and were believed to have a central line-associated bloodstream infection (CLABSI) according to International Pediatric Sepsis Consensus Conference (IPSCC) standards. The IPSCC indicates systemic inflammation and suspected bloodstream infections through rectal temperature exceeding 38.5°C or falling below 36.0°C; heart rate surpassing 180 beats/minute (for ≥30 minutes) or dropping below 100 beats/minute (for ≥30 minutes); mean respiratory rate exceeding 60 breaths/minute OR the need for mechanical ventilation due to an acute condition; leukocytosis greater than 34,000/mm³ (in full-term neonates aged 0–7 days) OR leukopenia below 5,000/mm³ OR the presence of immature forms (band neutrophils) exceeding 10% of total leukocytes. IPSCC criteria were fulfilled if a minimum of two criteria were satisfied—namely, combinations of temperature with leukocytes, temperature with heart rate, temperature with respiratory rate, leukocytes with heart rate, or leukocytes with respiratory rate or if three or four criteria were simultaneously met. Heart rate and respiratory rate combinations by themselves (excluding temperature or leukocyte abnormalities) were not considered qualifying criteria; thorough medical documentation concerning the condition was also necessary (Mseza, 2025; Schlapbach et al., 2024). The comparison control group included neonates in the neonatal intensive care units who lacked an indwelling catheter but were thought to exhibit inflammation according to IPSCC criteria. Patients lacking complete medical records or documentation of suspected CLABSI before CVC insertion were excluded from the analysis, whereas patients with incomplete medical records concerning suspected CLABSI who were not treated with CVC insertion acted as controls.

Instrument Calibration and Quality Control

No study-specific instruments requiring calibration were used because this study was based on retrospective medical-record data. Laboratory and clinical measurements were obtained from routinely calibrated hospital equipment according to institutional quality-control procedures. Data were checked against the original medical records to ensure completeness and accuracy.

Statistical Analysis

Data analysis was conducted using JASP software. Descriptive analysis was utilized; Spearman's correlation was applied for data that did not adhere to a normal distribution, and the relationship between the two parameters—CLABSI incidence and suspected bloodstream infection—was evaluated using Fisher's exact test and the Log Odds Ratio.

Ethical Considerations

The study was approved by the relevant Dr. Ramelan Hospitals institutional ethics committee no141/EC/KEP/2025. Patient confidentiality was maintained, and all data was anonymized before analysis.

RESULTS

During the study period, a total of 70 neonates admitted to the NICU with central venous catheters (CVCs) were screened for eligibility. Of these, 18 neonates were excluded based on the pre-specified exclusion criteria: 5 neonates presented with documented bloodstream infections prior to CVC placement, 13 neonates had incomplete medical records regarding catheter duration or infection status. In total, 52 neonates fulfilling the inclusion criteria were identified: 26 had a CVC inserted for over 48 hours and were suspected of CLABSI according to IPSCC criteria, while 26 showed systemic inflammation aligning with IPSCC criteria but lacked a CVC.

Table 1. Patient characteristics

Characteristic	Mean± SD	Shapiro-Wilk	P-value of Shapiro-Wilk
Neonatal age (days)	4.885 ± 6.767	0.6378	< .001
Length of time for CVC placement / duration of ICU admission (days)	15.15 ± 10.68	0.7160	< .001
Initial temperature maintained or before CVC installation (°C)	36.38 ± 1.47	0.3212	< .001
Last temperature maintained or after CVC installation (°C)	36.64 ± 1.426	0.2409	< .001
Initial Pulse maintained or before CVC installation (beat/ minutes)	140.5 ± 12.03	0.9153	0.001
Last Pulse maintained or after CVC installation (beat/ minutes)	141.6 ± 4.132	0.7442	< .001
Initial respiratory rate maintained or before CVC installation (breaths / minutes)	44.21 ± 10.52	0.9211	0.002
Last respiratory rate maintained or after CVC installation (breaths / minutes)	46.42 ± 6.207	0.7627	< .001
Initial leucocytes maintained or before CVC installation (breaths / minutes) (×10 ³ /μL)	14.38 ± 6.142	0.9029	< .001
Last leucocytes maintained or after CVC installation (breaths / minutes) (×10 ³ /μL)	13.73 ± 7.860	0.8860	< .001

The data results show that the majority of respondents were male, numbering 30 people (57.7%), while female respondents numbered 22 people (42.3%) The outcomes of the Shapiro-Wilk

analysis and p-values suggest that the data do not follow a normal distribution; therefore, the analysis utilized a non-parametric method with the Spearman test, as illustrated in Table 2.

Table 2. Association among variables utilizing the Spearman test

Variable	Variable	Spearman rho	p-value
Neonatal age (days)	Length of time for CVC placement / duration of ICU admission (days)	0.2302	.101
Neonatal age (days)	Initial temperature maintained or before CVC installation (°C)	0.1234	.383
Neonatal age (days)	Last temperature maintained or after CVC installation (°C)	-0.08682	.541
Neonatal age (days)	Initial Pulse maintained or before CVC installation (beat/ minutes)	-0.1751	.214
Neonatal age (days)	Last Pulse maintained or after CVC installation (beat/ minutes)	-0.05533	.697
Neonatal age (days)	Initial respiratory rate maintained or before CVC installation (breaths / minutes)	-0.02602	.855
Neonatal age (days)	Last respiratory rate maintained or after CVC installation (breaths / minutes)	0.06026	.671
Neonatal age (days)	Initial leucocytes maintained or before CVC installation ($\times 10^3/\mu\text{L}$)	-0.2638	.059
Neonatal age (days)	Last leucocytes maintained or after CVC installation ($\times 10^3/\mu\text{L}$)	0.07786	.583
Length of time for CVC placement / duration of ICU admission (days)	Initial temperature maintained or before CVC installation (°C)	0.2301	.101
Length of time for CVC placement/duration of ICU admission (days)	Last temperature maintained or after CVC installation (°C)	0.05039	.723
Length of time for CVC placement/duration of ICU admission (days)	Initial Pulse maintained or before CVC installation (beat/ minutes)	0.07867	.579
Length of time for CVC placement/duration of ICU admission (days)	Last Pulse maintained or after CVC installation (beat/ minutes)	-0.1522	.281
Length of time for CVC placement/duration of ICU admission (days)	Initial respiratory rate maintained or before CVC installation (breaths / minutes)	0.1821	.196
Length of time for CVC placement/duration of ICU admission (days)	Last respiratory rate maintained or after CVC installation (breaths / minutes)	0.3247	.019
Length of time for CVC placement/duration of ICU admission (days)	Initial leucocytes maintained or before CVC installation ($\times 10^3/\mu\text{L}$)	-0.3335	.016
Length of time for CVC placement/duration of ICU admission (days)	Last leucocytes maintained or after CVC installation ($\times 10^3/\mu\text{L}$)	0.06977	.623
Initial temperature maintained or before CVC installation (°C)	Last temperature maintained or after CVC installation (°C)	0.01321	.926
Initial temperature maintained or before CVC installation (°C)	Initial Pulse maintained or before CVC installation (beat/ minutes)	-0.06603	.642
Initial temperature maintained or before CVC installation (°C)	Last Pulse maintained or after CVC installation (beat/ minutes)	-0.1915	.174
Initial temperature maintained or before CVC installation (°C)	Initial respiratory rate maintained or before CVC installation (breaths / minutes)	0.04195	.768
Initial temperature maintained or before CVC installation (°C)	Last respiratory rate maintained or after CVC installation (breaths/minutes)	0.1184	.403

Variable	Variable	Spearman rho	p-value
Initial temperature maintained or before CVC installation (°C)	Initial leucocytes maintained or before CVC installation ($\times 10^3/\mu\text{L}$)	-0.01442	.919
Initial temperature maintained or before CVC installation (°C)	Last leucocytes maintained or after CVC installation ($\times 10^3/\mu\text{L}$)	-0.1451	.305
Last temperature maintained or after CVC installation (°C)	Initial Pulse maintained or before CVC installation (beat/ minutes)	-0.1358	.337
Last temperature maintained or after CVC installation (°C)	Last Pulse maintained or after CVC installation (beat/ minutes)	-0.1922	.172
Last temperature maintained or after CVC installation (°C)	Initial respiratory rate maintained or before CVC installation (breaths/minutes)	-0.1313	.353
Last temperature maintained or after CVC installation (°C)	Last respiratory rate maintained or after CVC installation (breaths / minutes)	-0.1711	.225
Last temperature maintained or after CVC installation (°C)	Initial leucocytes maintained or before CVC installation ($\times 10^3/\mu\text{L}$)	0.1703	.228
Last temperature maintained or after CVC installation (°C)	Last leucocytes maintained or after CVC installation ($\times 10^3/\mu\text{L}$)	-0.07702	.587
Initial Pulse maintained or before CVC installation (beat/ minutes)	Last Pulse maintained or after CVC installation (beat/ minutes)	0.2284	.103
Initial Pulse maintained or before CVC installation (beat/ minutes)	Initial respiratory rate maintained or before CVC installation (breaths/minutes)	0.2161	.124
Initial Pulse maintained or before CVC installation (beat/ minutes)	Last respiratory rate maintained or after CVC installation (breaths / minutes)	-0.01409	.921
Initial Pulse maintained or before CVC installation (beat/ minutes)	Initial leucocytes maintained or before CVC installation ($\times 10^3/\mu\text{L}$)	0.1103	.436
Initial Pulse maintained or before CVC installation (beat/ minutes)	Last leucocytes maintained or after CVC installation ($\times 10^3/\mu\text{L}$)	-0.1158	.414
Last Pulse maintained or after CVC installation (beat/ minutes)	Initial respiratory rate maintained or before CVC installation (breaths/minutes)	0.005335	.970
Last Pulse maintained or after CVC installation (beat/ minutes)	Last respiratory rate maintained or after CVC installation (breaths / minutes)	0.01026	.942
Last Pulse maintained or after CVC installation (beat/ minutes)	Initial leucocytes maintained or before CVC installation ($\times 10^3/\mu\text{L}$)	0.1232	.384
Last Pulse maintained or after CVC installation (beat/ minutes)	Last leucocytes maintained or after CVC installation ($\times 10^3/\mu\text{L}$)	-0.06242	.660
Initial respiratory rate maintained or before CVC installation (breaths/minutes)	Last respiratory rate maintained or after CVC installation (breaths / minutes)	0.2682	.055
Initial respiratory rate maintained or before CVC installation (breaths/minutes)	Initial leucocytes maintained or before CVC installation ($\times 10^3/\mu\text{L}$)	0.1127	.426
Initial respiratory rate maintained or before CVC installation (breaths/minutes)	Last leucocytes maintained or after CVC installation ($\times 10^3/\mu\text{L}$)	-0.01780	.900
Last respiratory rate maintained or after CVC installation (breaths / minutes)	Initial leucocytes maintained or before CVC installation ($\times 10^3/\mu\text{L}$)	-0.2326	.097
Last respiratory rate maintained or after CVC installation (breaths / minutes)	Last leucocytes maintained or after CVC installation ($\times 10^3/\mu\text{L}$)	0.01341	.925
Initial leucocytes maintained or before CVC installation ($\times 10^3/\mu\text{L}$)	Last leucocytes maintained or after CVC installation ($\times 10^3/\mu\text{L}$)	0.3187	.021

Based on the table 2, The outcomes of the Spearman statistical analyses among variables indicated a lack of significance in nearly every instance, except for length of time for CVC placement/duration of ICU admission (days) vs. final respiratory rate (breaths/minute) (Spearman rho

0.3247, p-value 0.19); length of time for CVC placement/duration of ICU admission (days) vs. initial leukocyte count ($\times 10^3/\mu\text{L}$) (Spearman rho -0.3335, p-value 0.21); and initial leukocyte count vs. final leukocyte count (Spearman rho 0.3187, p-value 0.21).

Table 3. CVC placement and suspected bloodstream infection cross-tabulation

Characteristic	Suspected Blood stream infection				Amount
	Yes	%	No	%	
CVC placement status					
Yes	1	4	25	96	26
No	1	4	25	96	26
	2		50		52

The cross-tabulation findings related to CVC placement and suspected bloodstream infection indicate that merely one patient with a CVC displayed symptoms of a suspected bloodstream infection, and similarly, just one patient without a CVC exhibited signs of a suspected bloodstream infection.

Table 4. Log odd ratio

95% Confidence Intervals				
	Estimate	Lower	Upper	p
Log Odds Ratio	0.00	-2.827	2.827	
Fisher's exact test	0.00	-4.401	4.401	1.000

Following that, additional analysis was performed using Fisher's Exact Test. The findings showed no meaningful link between CVC placement and the development of infection ($p=1.000$, $p>0.05$). The Log Odds Ratio of 0.00 (95% CI: -2.827 to 2.827) suggests that the infection risk was not significantly different between the CVC group and the non-CVC group.

DISCUSSION

This retrospective cohort study evaluated the association between central venous catheter (CVC) placement and subsequent suspected bloodstream infection among neonates admitted to the NICU. The findings demonstrated a significant association between CVC exposure and suspected bloodstream infection. These findings support the importance of CVC-related factors in the occurrence of bloodstream infection among hospitalized neonates.(Nielsen et al., 2022; Pitiriga et al., 2024)

Data was gathered from 52 neonates: 26 with a central venous catheter (CVC) and 26 without one. The average age was 4.885 ± 6.767 days, and the average length of CVC placement or ICU admission was 15.15 ± 10.68 days. No parameters applied to evaluate potential sepsis according to the IPSCC criteria demonstrated a mean rise. Neonatal infections commonly manifest as early-onset sepsis within 72 hours of delivery, arising from elements like maternal genital infections, premature membrane rupture, maternal fever during labor, and urinary tract infections in the mother. (Althagafi et al., 2022; Kariniotaki et al., 2025; Russell et al., 2024) The bacteria most frequently responsible are Group B Streptococcus (GBS), Escherichia coli, and Listeria monocytogenes.(Poggi et al., 2025; Song et al., 2022; Wang et al., 2025) In contrast, infections that begin later—more than 72 hours after birth—are often due to healthcare-related (nosocomial) infections. These stem from elements like vascular catheter insertion causing bloodstream infections; fragile skin and the umbilical cord enabling bacterial growth and acting as entryways for systemic infection; bacterial growth linked to parenteral administration; and contamination of respiratory support devices.(Flannery et al., 2022; Russell et al., 2024). Coagulase-negative staphylococci (CoNS), Staphylococcus aureus, Klebsiella pneumoniae, Pseudomonas aeruginosa, and fungal infections (Candidasp.) are pathogens that lead to late-onset sepsis in newborns.(Gu et al., 2026; Russell et al., 2024)

Temperature, pulse, respiratory rate, and leukocyte levels are straightforward parameters utilized to identify systemic infection according to IPSCC criteria. Study findings revealed noteworthy results concerning CVC placement/length of stay in the intensive care unit in relation to final respiratory rate ($p=0.19$), initial leukocyte count ($p=0.16$), and the comparison of initial and final leukocyte counts ($p=0.21$), although the relationships were weak. Alterations in neonatal temperature result from the secretion of endogenous pyrogens—like interleukins (IL-1, IL-6) and Tumor Necrosis

Factor-alpha (TNF- α)—by immune cells; these compounds modify the thermoregulatory set-point in the hypothalamus. Hypothermia poses a greater risk than hyperthermia in newborns because of an underdeveloped thermoregulatory center in the brain, insufficient brown fat stores, and a high surface area relative to body weight. In a significant inflammatory response or sepsis, the body faces energy insufficiency; this often happens in premature and low-birth-weight babies. Contact with inflammatory cytokines induces general vasodilation and capillary leakage, resulting in relative hypovolemia. Physiologically, the body seeks to sustain perfusion by raising cardiac output and stimulating the sympathetic nervous system, leading to tachycardia. On the other hand, myocardial underdevelopment in newborns restricts volume compensation, while intense systemic inflammation or tissue oxygen shortage may result in myocardial impairment. This appears as neonatal bradycardia, acting as a warning indicator of cardiac decompensation. The respiratory system's inflammatory response is marked by tachypnea, which seeks to remove excess carbon dioxide and bring blood pH back to normal levels. Inflammatory cytokines harm the alveolar-capillary matrix in the lungs, causing injury and elevating the effort required for breathing. Leukocytes, serving as the body's initial defense, multiply in count during instances of inflammation or infection. Nonetheless, if the situation deteriorates, there is an overconsumption of cells in peripheral tissues that surpasses the production ability of the bone marrow. This results in leukopenia. The "shift to the left" effect also drives the bone marrow to discharge significant quantities of immature neutrophils into the bloodstream.(Biutifasari et al., 2024; Bladon et al., 2024; Jung et al., 2020; Sikora et al., 2023)

This research discovered an extremely low occurrence of suspected catheter-associated bloodstream infection namely central line-associated bloodstream infection (CLABSI) with just one instance happening among 26 neonates equipped with a central venous catheter (CVC). This outcome indicated no notable difference in comparison to neonates undergoing intensive care without a CVC ($p=1.0$). CVC placement is an invasive intervention in newborns that poses a risk of CLABSI; maintaining safety throughout the procedure aids in preventing subsequent infections. Strict compliance with CVC placement guidelines—such as selecting the appropriate catheter type—lowers infection rates. Peripherally Inserted Central Catheters (PICCs) have a reduced infection risk compared to central lines inserted in the jugular or subclavian veins because of variations in the insertion locations. Umbilical venous catheters are considered safe for a duration of 5 to 7 days; however, using them beyond seven days raises the likelihood of infection. Prevention initiatives should also be reinforced by ensuring optimal asepsis and choosing the correct insertion site, in addition to standard care, limited catheter handling, and prompt removal once the medical necessity has been addressed(Elabbasy et al., 2024; Hanif et al., 2023; Manzoni et al., 2025; Pappa et al., 2025; Perme, 2023; Schiefer et al., 2021)

Central venous catheter (CVC) insertion is an invasive procedure commonly performed to obtain central venous access in critically ill patients. This procedure requires strict adherence to aseptic techniques to prevent bloodstream infections, particularly central line-associated bloodstream infection (CLABSI), which is associated with increased morbidity and mortality (Prestel et al., 2023; Romanelli et al., 2025). Catheter-related infections remain a frequent complication across different age groups and sexes and may contribute significantly to adverse clinical outcomes. When pathogen virulence increases and host immune defenses are compromised, microorganisms may colonize the catheter and surrounding tissues, leading to infection despite preventive measures (Erayman et al., 2026; Pasilan et al., 2024).

Theoretically, CLABSI may occur through several mechanisms, including colonization of the skin at the insertion site, contamination of the catheter hub, hematogenous spread from other infection sources, and infusion of contaminated fluids. Among both adult and pediatric populations, skin flora migration from the insertion site to the central vein represents the most common pathway of infection (Buetti et al., 2022; Haddadin et al., 2022; Kang et al., 2026). These mechanisms underscore the critical importance of optimal catheter insertion and maintenance practices.

CVCs may contribute to bloodstream infection through microbial migration along the catheter, contamination during catheter manipulation, and biofilm formation on the catheter surface. These mechanisms may become more relevant with continued catheter exposure and repeated catheter access. In the present study, the observed association between CVC exposure and suspected

bloodstream infection supports the importance of appropriate catheter insertion and maintenance under aseptic conditions and regular assessment of the ongoing need for central venous access. (Portero-prados et al., 2026; Prawira et al., 2026). However, the findings do not establish a specific catheter-duration threshold for infection risk the extraluminal mechanism takes place during the early stage of catheter insertion (7-14 days), where typical skin flora like *Staphylococcus epidermidis* or *Staphylococcus aureus* moves into the puncture site. This will be worsened by non-sterile insertion methods, insufficient disinfection, and the use of soiled or damp dressings. The intraluminal mechanism happens when the catheter has been positioned for over 14 days, allowing microorganisms to directly enter the catheter. This process takes place when staff handle catheter scrub, or when concentrated infusion/parenteral fluids become contaminated, leading to bacterial proliferation. Invading bacteria rapidly establish a biofilm and play a role in antibiotic resistance. Tiny pieces of the biofilm with clusters of bacteria can occasionally enter the bloodstream, causing systemic bacteremia (Ge et al., 2026; Haddadin et al., 2022; Poggi et al., 2025).

From a clinical perspective, the findings emphasize the importance of appropriate CVC management in neonates. Central-line infection prevention generally involves both insertion and maintenance practices. Insertion bundles focus on aseptic catheter placement, appropriate skin antisepsis, and other measures during catheter insertion, whereas maintenance bundles address ongoing catheter care, including appropriate hub access and catheter-site management. Current CDC guidance recommends bundled interventions incorporating both insertion and maintenance practices as part of NICU CLABSI prevention efforts. However, compliance with these practices was not assessed in the present study; therefore, their contribution to the observed association cannot be determined. These measures should be considered general infection-prevention practices rather than direct explanations of our findings (Bayoumi et al., 2022; Elabbasy et al., 2024; World Health Organization, 2024).

Several limitations should be considered. First, the retrospective single-center design and relatively small sample size may limit the generalizability of the findings. Second, residual confounding is possible because neonates requiring CVCs may have greater illness severity than those who do not require central venous access. Factors such as gestational age, birth weight, mechanical ventilation, parenteral nutrition, antibiotic exposure, duration of hospitalization, and frequency of catheter manipulation may influence infection risk. Third, the outcome was based on suspected bloodstream infection rather than necessarily CDC/NHSN-defined CLABSI in all patients. Therefore, misclassification cannot be excluded. Fourth, baseline pulse rate, respiratory rate, temperature, and leukocyte count were obtained as single measurements at CVC placement/within the first 48 hours and therefore represent baseline status rather than clinical changes occurring at the time of infection. no distinction is made regarding the type of catheter

CONCLUSION

CVC use was not associated with suspected bloodstream infection among neonates admitted to the NICU in this study.

CONFLICT OF INTEREST

The authors declared there is no conflict of interest.

ACKNOWLEDGEMENTS

The authors would like to thank Faculty of Medicine, Universitas Hang Tuah and dr. Ramelan Naval Hospital, Surabaya, Indonesia, and all the supervisors who willingly contributed to the progress of this research.

REFERENCES

- Althagafi, T. H., Alharbi, M. A., Bamarhool, A. N., Almajed, Z. D., Natto, L. H., ...& Ismail, H. I. (2022). *Etiology and risk factors of early and late onset neonatal sepsis*. 9(1), 486–491. <https://dx.doi.org/10.18203/2394-6040.ijcmph20214840>

- Bayoumi, M. A. A., van Rens, M. F. P. T., Chandra, P., Masry, A., D'Souza, S., ...& Elmalik, E. E. (2022). Does the antimicrobial-impregnated peripherally inserted central catheter decrease the CLABSI rate in neonates? Results from a retrospective cohort study. *Frontiers in Pediatrics*, 10(November), 1–14. <https://doi.org/10.3389/fped.2022.1012800>
- Biutifasari, V., Untari, N. K. S. D., Nugraheni, P. A., Adiwinoto, R. P., Pratiknya, D. E., ...& Tambunan, B. A. (2024). Hyperbaric Oxygen Therapy Increases Brain-Derived Neurotrophic Factor as well as Decreases Systemic Immune-Inflammatory Index and Systemic Inflammatory Response Index in Autism Spectrum Disorder. *Indonesian Biomedical Journal*, 16(6), 534–539. <https://doi.org/10.18585/inabj.v16i6.3358>
- Bladon, S., Ashiru-Oredope, D., Cunningham, N., Pate, A., Martin, G. P., ...& van Staa, T. P. (2024). Rapid systematic review on risks and outcomes of sepsis: the influence of risk factors associated with health inequalities. In *International Journal for Equity in Health*, 23(1). BioMed Central Ltd. <https://doi.org/10.1186/s12939-024-02114-6>
- Buetti, N., Rupp, M. E., Marschall, J., Drees, M., Med, L. H., ...& Do, L. A. M. (2022). *Strategies to prevent central line-associated bloodstream infections in acute-care hospitals : 2022 Update*. 553–569. <https://doi.org/10.1017/ice.2022.87>
- Bunn, J. D., & Cornish, N. E. (2025). Blood Culture Contamination and Diagnostic Stewardship: From a Clinical Laboratory Quality Monitor to a National Patient Safety Measure. *Journal of Applied Laboratory Medicine*, 10(1), 162–170. <https://doi.org/10.1093/jalm/jfae132>
- Buttera, M., Lunt, C. L., Buettcher, M., Lehnick, D., & Stocker, M. (2025). *The impact of central line - specific dwell - times for neonatal central line associated bloodstream infections*. *Antimicrob Resist Infect Control*, 26(14):106. <https://doi.org/10.1186/s13756-025-01618-2>
- Elabbasy, A., Alkorbi, H. A., Padua, I., Abuharb, A. I., Alshedookhi, A. A., & Al-, H. (2024). *Central venous catheter insertion profile and complications among neonates in Saudi Arabia : a cross- - sectional study*. 1–8. <https://doi.org/10.1136/bmjopen-2024-089554>
- Erayman, İ., Kandemir, B., Bulut, R., Akgül, M., Uyar, M., & Kepenek Kurt, E. (2026). Healthcare-associated infections before and during the pandemic: Four-year follow-up. *BMC Infectious Diseases*, 26, 491. <https://doi.org/10.1186/s12879-026-12766-0>
- Flannery, D. D., Edwards, E. M., Coggins, S. A., Horbar, J. D., & Puopolo, K. M. (2022). Late-onset sepsis among very preterm infants. *Pediatrics*, 150(6), e2022058813. <https://doi.org/10.1542/peds.2022-058813>
- Catho, G., Rosa Mangeret, F., Sauvan, V., Chraïti, M.-N., Pfister, R., ...& Buetti, N. (2023). Risk of catheter-associated bloodstream infection by catheter type in a neonatal intensive care unit : a large cohort study of more than 1100 intravascular catheters. *Journal of Hospital Infection*, 139, 6–10. <https://doi.org/10.1016/j.jhin.2023.06.011>
- Ge, Y., Wang, Y., He, X., Wang, Y., & Li, X. (2026). Comprehensive management of hemodialysis catheter-related bloodstream infections: a narrative review. *Frontiers in Cellular and Infection Microbiology*, 16(June), 1–17. <https://doi.org/10.3389/fcimb.2026.1822898>
- Gu, Y., Geng, H., Wang, H., & Zhu, X. (2026). *Clinical features and risk factors of neonatal late-onset sepsis complicated by purulent meningitis*. (January), 1–9. <https://doi.org/10.3389/fped.2026.1704622>
- Haddadin, Y., Annamaraju, P., & Regunath, H. (2022). *Central Line-Associated Bloodstream Infection (CLABSI)*. StatPearls.
- Hanif, I., Alsuwailam, H. S., Almazyad, M. M., Almadani, L. A., & Alenezi, R. H. (2023). *Review Article Overview on Central Venous Access in Pediatric Patients*. 3(May), 83–89. <https://doi.org/10.54293/smhj.v3i2.74>
- Jufan, A. (2024). Diagnosis dan manajemen CLABSI. *Jurnal Ilmu Kesehatan*, 18(1), 12–20. <https://doi.org/10.20473/jik.v18i1.2024.12-20>
- Jung, E., Romero, R., Yeo, L., Diaz-primer, R., Marin-concha, J., ...& Hsu, C. (2020). Seminars in Fetal and Neonatal Medicine The fetal inflammatory response syndrome : the origins of a concept , pathophysiology , diagnosis , and obstetrical implications. *Seminars in Fetal and Neonatal Medicine*, 25(4), 101146. <https://doi.org/10.1016/j.siny.2020.101146>

- Kang, Y., Guan, X., Chen, D., Fang, W., Hu, B., ...& Ouyang, B. (2026). Practice guideline on the prevention and treatment of central line-associated bloodstream infection: Part 2 – Treatment. *Journal of Intensive Medicine*, 6(3), 197–213. <https://doi.org/10.1016/j.jointm.2025.10.009>
- Kariniotaki, C., Thomou, C., Gkentzi, D., Panteris, E., Dimitriou, G., & Hatzidaki, E. (2025). *Neonatal Sepsis : A Comprehensive Review*. 1–24. <https://doi.org/10.3390/antibiotics14010006>
- Kartikeswar, G. A. P., Parikh, T. B., Randive, B., Kinikar, A., Rajput, U. C., ...& Johnson, J. (2023). Bloodstream infections in neonates with central venous catheters in three tertiary neonatal intensive care units in Pune, India. *Journal of Neonatal-Perinatal Medicine*, 16(3), 507–516. <https://doi.org/https://doi.org/10.3233/npm-221110>
- Kochanowicz, J. F., Nowicka, A., Saad, S. R. Al, & Karbowski, L. M. (2022). Catheter - related bloodstream infections in infants hospitalized in neonatal intensive care units : a single center study. *Scientific Reports*, (0123456789), 1–7. <https://doi.org/10.1038/s41598-022-17820-w>
- Manzoni, P., Kaufman, D. A., Niklas, V., Giuffrè, M., Sylvie, A., & Luca, D. De. (2025). Expert review of CLABSI prevention in the NICU : supporting the transition of investigational drugs into clinical practice. *European Journal of Pediatrics*. <https://doi.org/10.1007/s00431-025-06329-9>
- Mseza, B. (2025). *Optimizing Pediatric Sepsis Diagnosis : A Narrative Review of Two Decades of Evolution from SIRS to Phoenix Consensus*. (September), 5187–5192. <https://doi.org/10.2147/IDR.S544164>
- National Healthcare Safety Network. (2025). Bloodstream Infection Event (Central Line-Associated Bloodstream Infection and Non-central Line Associated Bloodstream Infection) Bloodstream Infection Event (Central Line-Associated Bloodstream Infection and Non-central Line Associated Bloodstream Infection. *Cdc*, (January), 1–47. https://www.cdc.gov/nhsn/pdfs/pscmanual/4psc_clabscurrent.pdf
- Nielsen, C. L., Zachariassen, G., & Holm, K. G. (2022). Central line-associated bloodstream infection in infants admitted to a level III neonatal intensive care unit. *Danish Medical Journal*, 69(5), A05210463
- World Health Organization. (2024). *Surveillance of health care-associated infections at national and facility levels*. <https://www.who.int/publications/i/item/9789240101456>
- Pappa, O., Lynn, M., Davey, N. J., & Mullins, N. J. (2025). *A lifeline : enhancing neonatal central venous catheter safety*. 192–196. <https://doi.org/10.1136/archdischild->
- Pasilan, R. M., Dominique, I., Amante, T., & Dimacali, C. T. (2024). The epidemiology and microbiology of central venous catheter related bloodstream infections among hemodialysis patients in the Philippines : a retrospective cohort study. *BMC Nephrology*. <https://doi.org/10.1186/s12882-024-03776-8>
- Perme, T. (2023). Central Lines and Their Complications in Neonates : A Case Report and Literature Review. *Children*, 11(1), 1–10. <https://doi.org/10.3390/children11010026>
- Pitiriga, V. C., Campos, E., Bakalis, J., Saroglou, G., & Tsakris, A. (2024). Differences in the Dwell Time of Peripherally Inserted Central Catheters between Patients with Catheter Colonization and Those Developing Central Line-Associated Bloodstream Infection: A Single Centre Retrospective Cohort Study. *Antibiotics*, 13(7). <https://doi.org/10.3390/antibiotics13070632>
- Poggi, C., Fontanelli, G., Ciarci, M., Sassudelli, G., Fazi, C., ...& Dani, C. (2025). A Quality Improvement Bundle to Reduce Central Line-Associated Bloodstream Infections in Neonatal Intensive Care Unit : An Observational Study. *Antibiotics*, 14(12), 1–11. <https://doi.org/10.3390/antibiotics14121208>
- Portero-prados, F. J., Pab, M., & Ponce-bland, A. (2026). Intensive & Critical Care Nursing Effectiveness of chlorhexidine gluconate – impregnated dressings in preventing central line – associated bloodstream infection in a paediatric intensive care unit : A randomised controlled trial. *Intensive & Critical Care Nursing*, 96. <https://doi.org/10.1016/j.iccn.2026.104441>
- Prawira, Y., Putri, N. D., & Lestari, D. P. (2026). Implementation of central venous access device care bundles using a plan-do-study- act approach to reduce central line-associated bloodstream infection in children at a tertiary hospital in Indonesia. *Frontiers in Pediatrics*, 1–8. <https://doi.org/10.3389/fped.2026.1718071>

- Prestel, C., Fike, L., Patel, P., Dudeck, M., Edwards, J., ...& Kuhar, D. (2023). A Review of Pediatric Central Line-Associated Bloodstream Infections Reported to the National Healthcare Safety Network : United States , 2016 – 2022. *Journal of the Pediatric Infectious Diseases Society*, 12(9), 519–521. <https://doi.org/10.1093/jpids/piad066>.
- Romanelli, M. D. C. R., Souza, G. G. De, Peruchi, J., Viana, R., & Oliveira, K. (2025). Risk factors for colonization / infection by resistant microorganisms in outbreaks in neonatal unit — a systematic review and meta-analysis. *Jornal de Pediatria*, 101(3), 297–311. <https://doi.org/10.1016/j.jped.2024.12.005>
- Russell, N., Barday, M., Okomo, U., Dramowski, A., Sharland, M., & Bekker, A. (2024). Early-versus late-onset sepsis in neonates e time to shift the paradigm ? *Clinical Microbiology and Infection*, 30(1), 38–43. <https://doi.org/10.1016/j.cmi.2023.07.023>
- Schiefer, J., Lichtenegger, P., Zimpfer, D., Hutschala, D., Kuessel, L., ...& Base, E. (2021). Performing central venous catheters in neonates and small infants undergoing cardiac surgery using a wireless transducer for ultrasound guidance: a prospective, observational pilot study. *BMC pediatrics*, 21(1), 341. <https://doi.org/10.1186/s12887-021-02822-w>
- Schlapbach, L. J., Watson, R. S., Sorce, L. R., Argent, A. C., Menon, K., ...& Society of Critical Care Medicine Pediatric Sepsis Definition Task Force (2024). International Consensus Criteria for Pediatric Sepsis and Septic Shock. *JAMA*, 331(8), 665–674. <https://doi.org/10.1001/jama.2024.0179>
- Selby, L. M., Rupp, M. E., & Cawcutt, K. A. (2021). Prevention of Central-Line Associated Bloodstream Infections: 2021 Update. *Infectious Disease Clinics of North America*, 35(4), 841–856. <https://doi.org/10.1016/j.idc.2021.07.004>
- Sikora, J. P., Karawani, J., & Sobczak, J. (2023). Neutrophils and the Systemic Inflammatory Response Syndrome (SIRS). *International journal of molecular sciences*, 24(17), 13469. <https://doi.org/10.3390/ijms241713469>
- Song, W. S., Park, H. W., Oh, M. Y., Jo, J. Y., Kim, C. Y., ...& Kim, E. A. (2022). Neonatal sepsis-causing bacterial pathogens and outcome of trends of their antimicrobial susceptibility a 20-year period at a neonatal intensive care unit. *Clinical and experimental pediatrics*, 65(7), 350–357. <https://doi.org/10.3345/cep.2021.00668>
- Wang, Q., Wu, F., & Li, T. (2025). Distribution and Antimicrobial Resistance Analysis of Blood Culture Isolates at a Chinese National Cardiovascular Regional Medical Center: A 7-Year Retrospective Study. *Infection and Drug Resistance*, 18, 4249–4262. <https://doi.org/10.2147/IDR.S545293>
- Zheng, X., Yu, J., Liu, L., Chen, L., & Jiang, M. (2023). *Dwell time and bloodstream infection incidence of umbilical venous catheterization in China*. 7(4), 239–246. <https://doi.org/10.1002/ped4.12403>