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Review Article

Central Line-associated Bloodstream Infections: CLABSI Care Bundle Approach of Prevention

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Abstract

Infections of the bloodstream that is caused by vascular catheters can be divided into two primary groups both bloodstream infections that can be traced back to catheters and those that can be traced back to central lines. There are clear differences between the two, despite the fact that they are interchangeable. Infections that cannot be traced to an infection unrelated to a catheter but still arise when a central venous catheter is present or within 48 h after the catheter has been withdrawn are referred to as having a "central line-associated bloodstream infection" (CLABSI). A "bundle" of catheter care refers to the provision of care utilizing a consistent combination of actions to reduce the risk of bloodstream infections associated with central lines CLABSIs. Hand hygiene, the use of maximum sterile barriers during line insertion, the washing of the insertion site with chlorhexidine, avoiding the use of the femoral and jugular sites for line insertion, and the timely removal of superfluous catheters are all components of this combination. The implementation of an evidence-based CLABSI prevention bundle and process monitoring by direct observation led to a considerable improvement in reducing the CLABSI rate in adult intensive care unit patients, which was then maintained over time.

Keywords: Bundle care, central line-associated bloodstream infections, prevention.

Introduction

To distribute medications that cannot be given by mouth or arm, central venous access includes inserting a large bore catheter or venous access device in a vein in the groin, neck, or upper chest. These catheters can be used to administer intravenous nourishment, blood products, vasoactive medications, and chemotherapy in addition to antibiotics and other treatments.[1] Moreover, central venous access is utilized in intensive care units to evaluate cardiac and venous function as well as to give patients intermittent or continuous renal replacement treatment. However, one of the main problems with using central venous catheters (CVCs) is the potential for infection brought on by bacteria. The colonization of CVCs by microorganisms, which can cause local or systemic infections and raise patient morbidity and mortality rates as well as financial burdens on the community, is one of the main issues connected with their usage, though.[2] Bloodstream infections brought on by vascular catheters fall under two main categories. Both bloodstream infections linked to catheters and those connected to central lines central line-associated bloodstream infection (CLABSIs). While being interchangeable, they have definite distinctions. The term CLABSI refers to infections that cannot be traced to an infection unrelated to a catheter yet arise when a CVC is present or within 48 h after the catheter has been withdrawn. An intravascular catheter is the source of a clinical diagnosis known as a catheter-associated blood stream infection CLABSI, which can be validated by quantitative culture or by comparing a catheter specimen with peripheral venous

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blood. One of the most prevalent nosocomial infections and a significant contributor to bloodstream infections, particularly in patients receiving critical care, is CLABSI. The majority of CLABSIs are contracted by CVCs, and new research has shown that these catheters carry a 64-fold higher risk of contracting the infection than peripheral catheters.[3]

Thousands of patients still contract bloodstream infections every year, with an average rate of 0–2.9/1000 CVC days (depending on the type of unit) and 1/1000 CVC days in critical care units, according to the Centers for disease control and prevention, which estimates that there have been 50% fewer CLABSIs in the US in recent years.[4] The estimated CLABSI rate was 7.66/1000 between August 2008 and July 2010 in four hospitals, according to a 2015 study by Zhang *et al*. in China that included 2631 cases spread over seven critical care units.

Microorganisms come in a variety of ages, immune levels, and illness severity levels. Staphylococcus and streptococcus were listed as the most prevalent microorganisms in the Meng *et al*. study, while a study from Spain found that Gram-positive cocci and yeasts were largely to blame for CLABSIs and catheter tip colonization. There has been a shift toward Gram-negative microorganisms associated with CLABSI, according to several recent investigations conducted in Europe and China.[5]

Many studies have demonstrated that the risk of developing bloodstream infections and other complications connected to catheter use differed depending on the site of insertion.[6] According to the insertion site, Deshpande *et al*. found no risk of catheter-related bloodstream infections in their analysis of the potential for infectious adverse effects associated with central venous catheterization. Another study showed the jugular venous site to be an independent risk factor for catheter colonization, and Deshpande *et al*. discovered that there was no difference in catheter colonization between subclavian, jugular, and femoral venous access site. Furthermore, recent prospective studies have reported that catheter colonization is lower when subclavian venous access site is used.[7-9]

Materials and Methods

Reviewers searched various databases for systematic reviews published in English language peer-reviewed journals. Relevant articles were identified by search engine; PubMed, Medline, SCOPUS, Research gate, Elsevier, and Google Scholar with the following key words: "CLABSI, Prevention, effectiveness, CLABSI care bundle, etc" [Figure 1].

Prevention of CVC-related infection

There are numerous established suggestions and standards for preventing bloodstream infections linked to central lines. The fundamental guidelines for preventing CLABSI have been grouped into the three categories of before CVC insertion, during CVC insertion, and after CVC insertion in the paragraphs below.

Before the CVC insertion

The use of unneeded central venous catheterization can be decreased by putting in place a checklist of the criteria and contraindications for CVC use. A thorough educational program to teach medical professionals about catheter insertion, maintenance, and care, to make sure all medical professionals involved in catheter care attend and complete the program, and to establish competency before inserting the catheter on their own.[10] Studies have shown that a doctor's experience and ability are crucial elements since they are negatively correlated with the risk of CLABSI. Furthermore, it is very helpful to receive simulation training for catheter placement during residency.[11]

During the CVC insertion

ICUs need a procedure, such as a checklist, to make sure infection prevention best practices are followed when inserting catheters. Many guidelines and research have recommended the use of checklists to ensure safe insertion procedures. It is advised to have a nurse or doctor who has received training in CLABSI prevention measures oversee the maintenance of aseptic practices. The nurse or physician supervisor has the power to halt the procedure if aseptic techniques are not followed during catheter placement, with the exception of emergencies.[12]

It is advised to wash your hands with water and alcohol-based hand rubs or antimicrobial soaps (including antiseptics) before inserting or adjusting a catheter. Alcohol-based solutions and hand sanitizers work well against both Gram-positive and Gram-negative bacteria, as well as some pathogens such as MDR *Staphylococcus aureus*, MTB, and some viruses like HIV-encapsulated viruses. Alcohol has also been shown to lower hand bacterial levels.[13]

When the surgery is elective and the patient is obese, catheterization of the femoral vein is not advised. The infectious and non-infectious problems associated with the various CVC access locations are controversial, and different research have produced varied findings. The risks and benefits of CVC insertion must be evaluated against each other. For instance, jugular venous access CVC insertion may increase the risk of infection problems if a tracheostomy is present.

In ICUs and other CVC-using units, a catheter kit that includes all the supplies required for aseptic catheter installation must be readily accessible. Several studies have recommended using point-of-care ultrasounds to confirm catheter placement and assess problems after catheterization.[14]

It has been demonstrated that putting CVCs in under ultrasound guidance lower the risk of both infectious and non-infectious problems. According to studies, using ultrasound guidance lowers the risk of arterial damage, pulmonary embolism, deep vein thrombosis, and pneumothorax. The failure rate is decreased and time is saved using USS to find the vein.

Maximum barrier safety measures: While inserting a catheter, use the highest level of barrier protection, which includes a mask, a cap, a sterile drape, a sterile gown, and sterile gloves. There is proof that CLABSI rates in intensive care settings are decreased by approaches of maximum barrier precaution. [15,16]

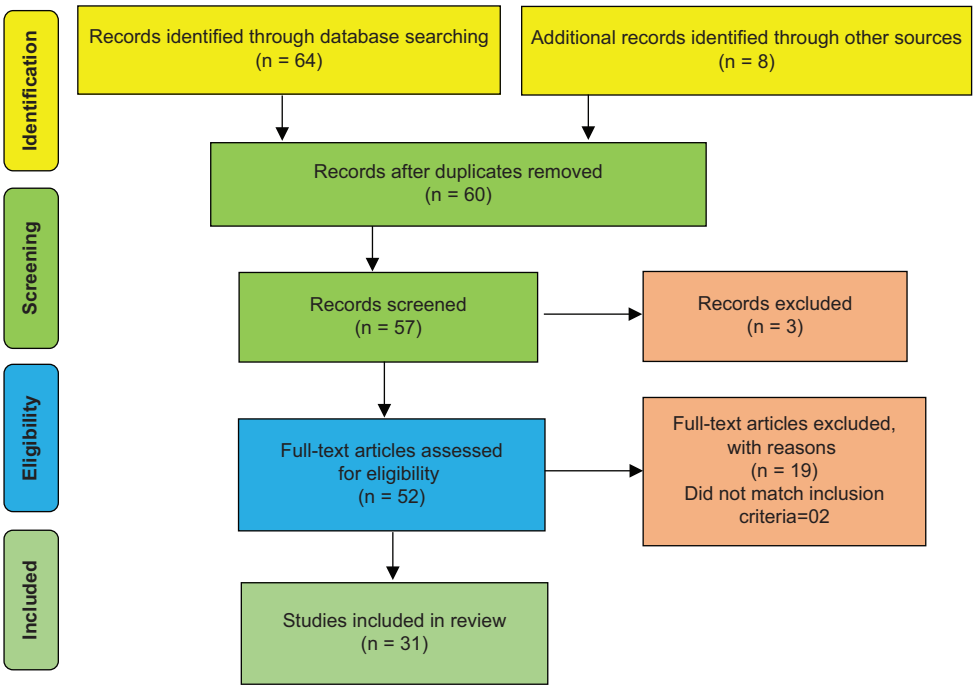

Figure 1: PRISMA diagram

The density of bacteria at the site of catheter insertion is the main risk factor for catheter-related BSI. One approach of prophylaxis is to prepare the skin with chlorohexidine. There is proof that chlorohexidine solution lessens infections caused by catheters. In a randomized experiment, chlorohexidine was found to be more effective at preventing catheter-related infections than 10% povidone-iodine, 70% alcohol, and 2% chlorohexidine solution.[17]

It is advisable to apply a 0.5% chlorohexidine gluconate solution to the skin where the needle was inserted. Its effectiveness is due to a synergistic interaction between alcohol and chlorhexidine. In an RCT comparing 5% povidone iodine solution in 70% ethanol with 10% aqueous povidone-iodine solution for skin antisepsis, povidone-iodine also demonstrated synergistic benefits. As comparison to povidone iodine alone, the alcohol povidone-iodine combination considerably reduced the incidence rates of catheter colonization. Further clinical trials are required to validate these findings, but it appears that chlorohexidine aqueous solution reduces infection complication rates more effectively than povidone-iodine and should be used as the first-line antisepsis for CVC management. CVCs that have been coated with antimicrobial or antisepsis should not help prevent CLABSI in adult patients.[18]

The use of antiseptic (chlorohexidine-silver sulfadiazine) coated CVCs or antibacterial (minocycline-rifampin) coated CVCs is one of the strategies suggested to lower CLABSI rates. The use of antimicrobial/antiseptic CVC, however, may not be helpful in lowering CLABSI rates, according to certain research. According to an RCT comparing antimicrobial coated CVCs with regular CVCs, neither the usage of antimicrobial-coated CVCs nor their use reduced the risk of CLABSI expressed per 1000 catheter days or the risk of catheter-related local infections.[19]

After catheter insertion

The usage of float nurses should be avoided, and there should be a sufficient nurse-to-patient ratio. The incidence rates of CLABSI have been proven to rise as a result of reducing the number of nurses below the threshold level. The number of float nurses should be kept to a minimum, according to studies, and there should be a ratio of 1–2 nurses in ICUs where nurses are caring for patients with CVCs. During a catheter evaluation, aseptic protocols are crucial. Hands must first be thoroughly cleaned with alcohol hand massage before manipulating catheter tubing. Chlorohexidine solutions should be used to sanitize hubs and ports before inspections. As catheter hubs are frequently checked rather than the actual catheter insertion site, prolonged catheterization raises the risk of catheter-related infection. The risks of CLABSI are increased by routinely manipulating central line catheters, particularly in aseptic circumstances.[20]

Catheters that are not required should be taken out. The need for the catheter should be assessed daily, and if it is no longer necessary for medical management, removal should be taken into consideration. To avoid bloodstream infections linked to CVCs, chlorhexidine-impregnated dressing should be applied.[21]

Chlorhexidine dressing placed over CVCs reduced the risk of CVC -related bloodstream infections from 1.3 infections per 1000 catheter days to 0.5 infections per 1000 catheter days in a randomized controlled trial involving 1636 adults. In a separate study involving 1879 patients, the same research group found that the same practice had a similar effect.[22]

The application of a chlorhexidine-impregnated sponge put on CVCs decreased the probability of catheter colonization and CVCs-bacteremia according to a meta-analysis investigations.[23]

The decline in infection rates has been linked to surveillance networks. The literature on establishing preventative programs has numerous instances that have been published.[24]

Catheter locks prophylaxis to stop thrombotic and infectious problems. To produce high antimicrobial concentrations and prevent or treat catheter-related infections, this approach involves flushing antibiotic solution into the lumens of CVCs over a predetermined length of time. Patients with long-term catheters or those who have previously experienced bloodstream infections connected to catheters are candidates for this surgery. Vancomycin, gentamycin, and minocycline are some of the antibiotics that have been used in these treatments; they are combined with anticoagulants such heparin to prevent long-term infections.[25] The use of antibiotic lock prophylaxis was linked to a 69% reduction in CLABSI rates and infection on the catheter exit site, according to a recent meta-analysis by Zacharioudakis *et al*. on 23 trials involving adult, pediatric, and cancer patients receiving TPN. Because there are not enough studies to judge the effectiveness of this method on short-term catheters, the use of antibiotic lock solutions on short-term catheters is debatable.[26,27]

Central line insertion bundle

The use of care bundles for the installation and upkeep of CVCs is a crucial method of CLABSI prevention. Care bundles are organized collections of practices that have been shown effective in improving patient outcomes and the delivery of care. They have been shown to significantly lower CLABSIs in patients in adult intensive care units. Recent research has demonstrated that care bundles can reduce CLABSIs in neonatal and pediatric intensive care units while also saving money.[28]

Hand hygiene

Wash hands or use an alcohol-based, waterless hand cleaner when caring for central lines:

- Before and after palpating the catheter insertion site
- Before and after inserting, replacing, adjusting, or dressing the site
- During palpation of the insertion site and after application of antiseptic and only if full asepsis is maintained.

Complete maximal barrier

- The operator inserting the CVC should adhere to strict aseptic techniques and wear sterile gloves, gown, surgical cap, and surgical mask.

Chlorhexidine 2% skin antisepsis

- Prepare skin with 2% chlorhexidine in 70% alcohol using swabs and a friction scrub for at least 30 s.

Do not wipe or blow dry and allow to dry completely before skin puncture: 30 s for a dry site.

2 min for a moist site (especially femoral).

Optimal catheter site selection

- In adult patients, there is some evidence that the subclavian site has a lower risk of catheter-related blood stream infections. However, there is usually more experience with the internal jugular site. The subclavian and internal jugulars are the preferred sites for infection control purposes.
- Use of sterile and single-use jelly.
- Use sterile and single-use jelly for ultrasound-guided insertions.

Central line maintenance bundle hand hygiene

Practice hand hygiene at five moments:

- Before touching a patient
- Before clean/aseptic procedures
- After body-fluid exposure/risk
- After touching a patient
- After touching patient surroundings.

Aseptic technique for accessing and changing needleless connectors

Scrub the access port or hub immediately before each use with an appropriate antiseptic.

Standardized tubing change

Intravenous medication administration tubing should be changed as per the recommendation in the local organizations policy.

Daily review of catheter necessity

Daily review of line necessity during rounds so that the necessity of the lines can be determined and unnecessary lines removed.

Evidence for effectiveness of CLABSI care bundle

The CLABSI rate per 1000 patient-days decreased from 3.1/1000 device-days to 0.4/1000 device days, according to a study by Gupta *et al*. Up until December 2018, when a single case occurred, we had gone 757 days without a case of CLABSI in the unit. After that, we have 602 days of freedom remaining as of July 2020. Conclusions A considerable and long-lasting improvement in lowering the CLABSI rate in adult CICU were made possible by the implementation of an evidence-based CLABSI prevention package and process monitoring through direct observation.[29]

According to the Entesari-Tatafi *et al*. study, the average CLABSI rate decreased from 2.2/1000 central line days during the pre-intervention period to 0.5/1000 central line days (0/1000 central line days from July 2012 to July 2014) during the post-intervention period (peaking at 5.2/1000 central line days in quarter 4, 2008). According to our study, this care bundle can significantly lower the CLABSI rate by employing a revolutionary maintenance approach.[30]

In accordance with the study by Sachan and Manu, three studies (27.2%) were conducted in North India, two (18.2%)

in North Taiwan, one (9.1%) in Canberra, one (9.1%) in Korea, one (9.1%) in Tennessee, one (9.1%) in Greece, one (9.1%) in Australia, and one (9.1%) in Turkey. These non-randomized intervention studies comprised all 11 studies that were a part of the systemic review. With the implementation of a care bundle in the critical care unit, analysis of all 11 trials shows that the rate of CLABSI significantly decreased.[31]

According to a research by Atilla *et al*., femoral access was more frequently seen and catheterization duration was higher in individuals with CLABSIs. Using the care bundle resulted in a reduction in CLABSI rates. For the first period, 6.20/1000 catheter days, the intervention period, 3.88/1000 catheter days, and the third period, 1.05/1000 catheter days, the CLABSI rate in the medical ICU was recorded. During these three intervals, the surgical ICU's CLABSI rate was 8.27/1,000, 4.60/1,000, and 3.73/1,000 catheter days, respectively. The CLABSI rate must be reduced through the selection of the best catheter insertion site, the implementation of all barrier precautions, and the removal of catheters when they are no longer required.[32]

Conclusion

CLABSIs are a type of healthcare-associated infection that is dangerous but can be avoided. CLABSI rates in an intensive care unit saw a considerable drop after the implementation of a comprehensive strategy that included multidisciplinary teams that adhered to an evidence-based, bundled approach.

References

1. Janum S, Zingg W, Classen V, Afshari A. Bench-to-bedside review: Challenges of diagnosis, care and prevention of central catheter-related bloodstream infections in children. Crit Care 2013;17:238.
2. Lorente L, Henry C, Martín MM, Jiménez A, Mora ML. Central venous catheter-related infection in a prospective and observational study of 2,595 catheters. Crit Care 2005;9:R631-5.
3. Marschall J, Mermel LA, Fakih M, Hadaway L, Kallen A, O'Grady NP, *et al.* Strategies to prevent central line-associated bloodstream infections in acute care hospitals: 2014 update. Infect Control Hosp Epidemiol 2014;35:753-71.
4. Centers for Disease Control and Prevention. Bloodstream Infection Event (Central Line-Associated Bloodstream Infection and Non-Central Line-Associated Bloodstream Infection). United Kingdom: Device-Associated Module BSI; 2017. p. 1-38.
5. Meng X, Fu J, Zheng Y, Qin W, Yang H, Cao D, *et al*. Ten-year changes in bloodstream infection with *Acinetobacter baumannii* complex in intensive care units in Eastern China: A retrospective cohort study. Front Med (Lausanne) 2021;8:715213.
6. Lorente L, Jiménez A, Iribarren JL, Jiménez JJ, Martín MM, Mora ML. The micro-organism responsible for central venous catheter related bloodstream infection depends on catheter site. Intensive Care Med 2006;32:1449-50.
7. Parienti JJ, Mongardon N, Mégarbane B, Mira JP, Kalfon P, Gros A, *et al*. Intravascular complications of central venous catheterization by insertion site. N Engl J Med 2015;373:1220-9.
8. Deshpande KS, Hatem C, Ulrich HL, Currie BP, Aldrich TK, Bryan-Brown CW, *et al*. The incidence of infectious complications of central venous catheters at the subclavian, internal jugular, and femoral sites in an intensive care unit population. Crit Care Med 2005;33:13-20.
9. Marik PE, Flemmer M, Harrison W. The risk of catheter-related bloodstream infection with femoral venous catheters as compared to subclavian and internal jugular venous catheters: A systematic review of the literature and meta-analysis. Crit Care Med 2012;40:2479-85.
10. Tang HJ, Lin HL, Lin YH, Leung PO, Chuang YC, Lai CC. The impact of central line insertion bundle on central line-associated bloodstream infection. BMC Infect Dis 2014;14:356.
11. Coopersmith CM, Zack JE, Ward MR, Sona CS, Schallom ME, Everett SJ, *et al*. The impact of bedside behavior on catheter-related bacteremia in the intensive care unit. Arch Surg 2004;139:131-6.
12. Tsuchida T, Makimoto K, Toki M, Sakai K, Onaka E, Otani Y. The effectiveness of a nurse-initiated intervention to reduce catheter-associated bloodstream infections in an urban acute hospital: An intervention study with before and after comparison. Int J Nurs Stud 2007;44:1324-33.
13. Parienti JJ, du Cheyron D, Timsit JF, Traoré O, Kalfon P, Mimoz O, *et al*. Meta-analysis of subclavian insertion and nontunneled central venous catheter-associated infection risk reduction in critically ill adults. Crit Care Med 2012;40:1627-34.
14. Ablordeppey EA, Drewry AM, Beyer AB, Theodoro DL, Fowler SA, Fuller BM, *et al*. Diagnostic accuracy of central venous catheter confirmation by bedside ultrasound versus chest radiography in critically Ill patients: A systematic review and meta-analysis. Crit Care Med 2017;45:715-24.
15. Montrief T, Auerbach J, Cabrera J, Long B. Use of point-of-care ultrasound to confirm central venous catheter placement and evaluate for postprocedural complications. J Emerg Med 2021;60:637-40.
16. Cho SY, Chung DR, Ryu JG, Choi JR, Ahn N, Kim S, *et al*. Impact of targeted interventions on trends in central line-associated bloodstream infection: A single-center experience from the republic of Korea. Crit Care Med 2017;45:e552-8.
17. Maiwald M, Chan ES. The forgotten role of alcohol: A systematic review and meta-analysis of the clinical efficacy and perceived role of chlorhexidine in skin antisepsis. PLoS One 2012;7:e44277.
18. Hanna H, Benjamin R, Chatzinikolaou I, Alakech B, Richardson D, Mansfield P, *et al*. Long-term silicone central venous catheters impregnated with minocycline and rifampin decrease rates of catheter-related bloodstream infection in cancer patients: A prospective randomized clinical trial. J Clin Oncol 2004;22:3163-71.
19. Lai NM, Chaiyakunapruk N, Lai NA, O'Riordan E, Pau WS, Saint S. Catheter impregnation, coating or bonding for reducing central venous catheter-related infections in adults. Cochrane Database Syst Rev 2016;3:CD007878.
20. Munoz-Price LS, Dezfulian C, Wyckoff M, Lenchus JD, Rosalsky M, Birnbach DJ, *et al*. Effectiveness of stepwise interventions targeted to decrease central catheter-associated bloodstream infections. Crit Care Med 2012;40:1464-9.
21. Parenti CM, Lederle FA, Impola CL, Peterson LR. Reduction of unnecessary intravenous catheter use. Internal medicine house staff participate in a successful quality improvement project. Arch Intern Med 1994;154:1829-32.
22. Timsit JF, Mimoz O, Mourvillier B, Souweine B, Garrouste-Orgeas M, Alfandari S, *et al*. Randomized controlled trial of chlorhexidine dressing and highly adhesive dressing for preventing catheter-related infections in critically ill adults. Am J Respir Crit Care Med 2012;186:1272-8.
23. Ullman AJ, Cooke ML, Mitchell M, Lin F, New K, Long DA, *et al*. Dressing and securement for central venous access devices (CVADs): A cochrane systematic review. Int J Nurs Stud 2016;59:177-96.
24. Bénet T, Ecochard R, Voirin N, Machut A, Lepape A, Savey A, *et al*. Effect of standardized surveillance of intensive care unit-acquired infections on ventilator-associated pneumonia incidence. Infect Control Hosp Epidemiol 2014;35:1290-3.
25. Centers for Disease Control and Prevention. National and State Healthcare-Associated Infections Progress Report. Washington, DC: Centers for Disease Control and Prevention; 2016.
26. Zacharioudakis IM, Zervou FN, Arvanitis M, Ziakas PD, Mermel LA, Mylonakis E. Antimicrobial lock solutions as a method to prevent central line-associated bloodstream infections: A meta-analysis of randomized controlled trials. Clin Infect Dis 2014;59:1741-9.
27. Lutufyo TE, Qin W, Chen X. Central line associated bloodstream infection in adult intensive care unit population-changes in epidemiology, diagnosis, prevention, and addition of new technologies. Adv Infect Dis 2022;12:252-80.

28. Cho HK. Catheter care bundle and feedback to prevent central line-associated bloodstream infections in pediatric patients. Clin Exp Pediatr 2021;64:119-20.
29. Gupta P, Thomas M, Patel A, George R, Mathews L, Alex S, *et al*. Bundle approach used to achieve zero central line-associated bloodstream infections in an adult coronary intensive care unit. BMJ Open Qual 2021;10:e001200.
30. Entesari-Tatafi D, Orford N, Bailey MJ, Chonghaile MN, Lamb-Jenkins J, Athan E. Effectiveness of a care bundle to reduce central line-associated bloodstream infections. Med J Aust 2015;202:247-9.
31. Sachan H, Manu J. Effectiveness of care bundles to prevent central line associated blood stream infection (CLABSI) in patient admitted in ICU-a systemic review. Int J Sci Res 2022;11:1053-7.
32. Atilla A, Doğanay Z, Çelik HK, Tomak L, Günal Ö, Kılıç SS. Central line-associated bloodstream infections in the intensive care unit: Importance of the care bundle. Korean J Anesthesiol 2016;69:599-603.

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