



The prevalence and main determinants of catheter-related bloodstream infections in children undergoing chemotherapy

Gholamreza Bahoush^{1*}, Masoumeh Jafari², Borna Arfaie³

¹Department of Pediatrics, Ali-Asghar Children Hospital, School of Medicine, Iran University of Medical Sciences, Tehran, Iran, Email: Bahoush.gh@iums.ac.ir

²Fellow of Pediatric Hematology and Oncology, Ali-Asghar Children Hospital, Faculty of Medicine, Iran University of Medical Sciences, Tehran, Iran.

³General Physician, Faculty of Medicine, Iran University of Medical Sciences, Tehran, Iran.

ABSTRACT

Background: One of the major complications of venous access ports placement especially in cancer patients scheduling for chemotherapy is infection. We aimed to investigate the frequency of catheter-related bloodstream infections (CRBSI) originated from chemotherapy catheter in children undergoing chemotherapy.

Methods: All cancer patients referred to the Hematology department at Ali Asghar Pediatric Hospital during 2006 to 2016 who underwent chemoport treatment were included into this retrospective cross-sectional study. CRBSI was considered in children with a portal chemotherapy with at least one positive blood culture obtained from a peripheral vein and catheter tip, clinical manifestations of infections, and no apparent source for the this infection, except the catheter.

Results: Overall, 36.42% of the subjects had chemotherapy port and 63.58% had no chemotherapy port. In total, 18.87% of all patients had blood infection and 81.13% had no infection. The rate of chemotherapy catheter insertion was strongly associated with higher rate of positive blood culture for infection ($p < 0.001$). In this regard, the rate of infection in the children with and without catheter was reported to be 64.9% and 29.8% respectively ($p < 0.001$). The most common bacterial strain discovered by blood culture in both groups with and without catheter was micrococcus subfamily. Regarding clinical outcome in those subgroups of children with and without chemotherapy port, the death rate was found to be 2.7% and 0.5% respectively with no difference ($p > 0.05$).



Conclusion: CRBSI is a common event in children suffering chemotherapy especially in higher ages.

ARTICLE HISTORY

Received October 12, 2020
Accepted November 14,
2020 Published December
02, 2020

KEYWORDS

Chemotherapy, CRBSI,
Childhood cancer,
Bacterial infections.

* **Contact:** Gholamreza Bahoush  Department of Pediatrics, Ali-Asghar Children Hospital, School of Medicine, Iran University of Medical Sciences, Tehran, Iran  Bahoush.gh@iums.ac.ir

2020 The Authors. This is an open access article under the terms of the Creative Commons Attribution Non-Commercial Share Alike 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>).

INTRODUCTION

Intravenous catheters are an integral part of modern medical treatment and are most commonly used in critically ill patients. These include administration of liquids, blood products, medications, nutritional solutions, as well as hemodynamic monitoring. Central venous catheter (CVC) catheters are more at risk for infections than other instruments, and are also more likely to be morbidity and mortality and identified as a major source of septicemia and bacteremia in hospitalized patients. Catheter-related bloodstream infections (CRBSI) are a bacteremia originating from an intravenous catheter. This phenomenon is one of the most common deadly and costly complications of central venous catheterization, as well as the most common cause of nosocomial bacteremia (1-3). According to the North American data from the National Nosocomial Infection Surveillance System (NNIS) from October 1986 to December 1990, the incidence of CRBSI has been reported to be ranged from 2.1 per 1,000 days of catheter use for respiratory ICUs to 30.2 per 1,000 days of catheter use for the burn section units (4). Closer NNIS data from January 1992 to June 2004 show that the median CRBSI incidence rate in all ICUs ranged from 1.8 to 5.2 per 1000 catheters (5). In an article published in 2011, the incidence of CRBSI was 8.75 per 1,000 days (6-10).

Overall, CRBSI can cause many economic and life costs annually. The most common cause of nosocomial infections is also known as catheter insertion. However, all of these can be prevented and only a few can be prevented. The use of quality promotion programs and training of health staff are very helpful for preventing such infections. Studies have shown that holding these programs greatly reduces the risk of catheter contamination (11-13). Implementation of such programs requires the allocation of funds and manpower, which cannot be achieved without an accurate estimate based on the epidemiology of the region. Therefore, in this study we aimed to investigate the frequency of CRBSI originated from chemotherapy catheter in patients undergoing chemotherapy referred to Ali Asghar Hospital in Iran between 2006 and 2016.

MATERIALS AND METHODS

All cancer patients referred to the Hematology department at Ali Asghar Pediatric Hospital during 2006 to 2016 who underwent chemoport treatment were included into this retrospective cross-sectional study. Then, all cases that were treated for systemic infection were evaluated for

frequency, type of infectious disease, treatment outcome, and ultimately the impact of these infections on the final outcome of patients. CRBSI definitions vary, but is a clinical definition typically requiring microbiological data identifying catheter as source of blood stream infection such as cultures of catheter tip and/or blood, and differential time to positivity. In this regard, in our study, CRBSI was considered is children with a portal chemotherapy with at least one positive blood culture obtained from a peripheral vein and catheter tip, clinical manifestations of infections, and no apparent source for this infection, except the catheter. Written informed consent was taken from all parents and the study protocols were approved by the ethical committee at Iran University of Medical Sciences.

For statistical analysis, results were presented as mean \pm standard deviation (SD) for quantitative variables and were summarized by frequency (percentage) for categorical variables. Continuous variables were compared using t test or Mann-Whitney test whenever the data did not appear to have normal distribution or when the assumption of equal variances was violated across the study groups. Categorical variables were, on the other hand, compared using chi-square test. P values of ≤ 0.05 were considered statistically significant. For the statistical analysis, the statistical software SPSS version 23.0 for windows (IBM, Armonk, New York) was used.

RESULTS

In this descriptive cross-sectional study, 36.75% were female and 63.25% were male that 70.53% aged 1 to 10 years and 29.47% aged 10 to 19 years. Overall, 36.42% of the subjects had chemotherapy port and 63.58% had no chemotherapy port. The presence of chemotherapy port was reported in 38.29% of boys and 33.33% of girls with no difference between the two genders ($p > 0.05$). Also, catheter insertion was found in 13.6% of children aged less than 10 years and 49.4% in older children with no significant difference ($p > 0.05$). In total, 18.87% of all patients had blood infection and 81.13% had no infection. The infection rate in those children aged lower than 10 years and older group was 13.6% and 31.5% respectively. As shown in Figure 1, the rate of chemotherapy catheter insertion was strongly associated with higher rate of positive blood culture for infection ($p < 0.001$). In this regard, the rate of infection in the children with and without catheter was reported to be 64.9% and 29.8% respectively ($p < 0.001$).

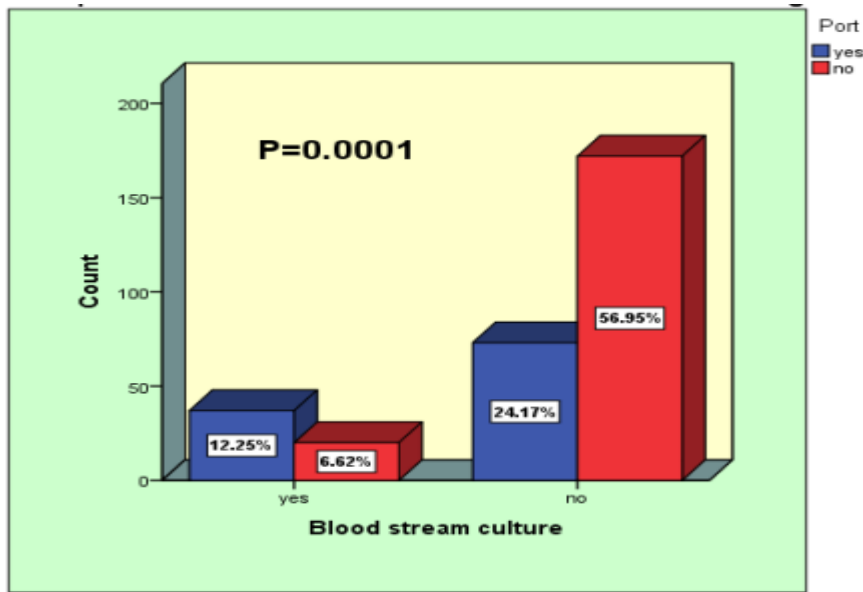


Fig.1: The rate of infection in patients with and without chemotherapy port access

As shown in Figure 2, the most common bacterial strain discovered by blood culture in both groups with and without catheter was micrococcus subfamily. Regarding clinical outcome in those

subgroups of children with and without chemotherapy port, the death rate was found to be 2.7% and 0.5% respectively with no difference ($p > 0.05$).

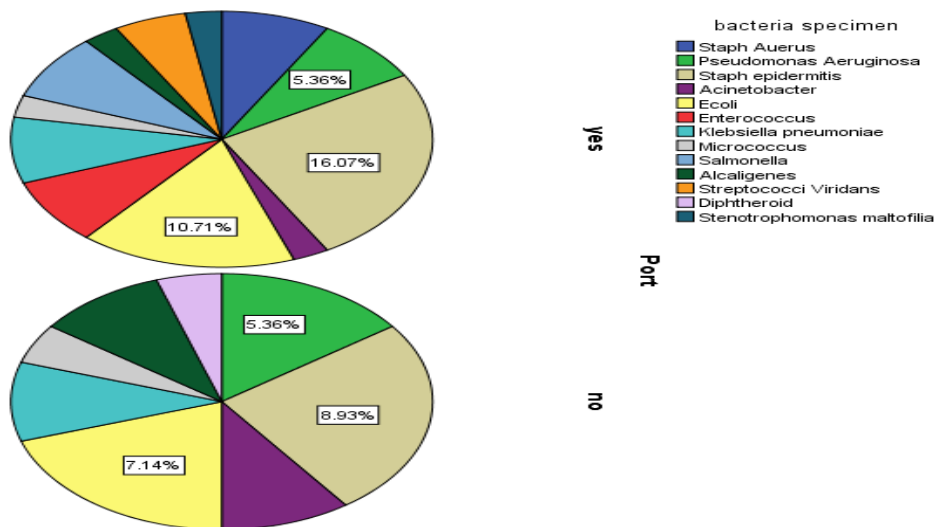


Fig.2: The common bacterial strains in children with and without chemotherapy port access

The in-hospital death occurred in 0.5% of patients aged under 10 years and 3.4% of older children indicating a significant difference ($p = 0.042$). The early death was also more prevalence in children with blood culture positivity as compared to non-infectious ones (7.0% versus 0.0%, $p = 0.001$). Also, the death rate was similar in boys and girls (1.6% versus 0.9%, $p = 0.622$). Ultimately, higher age ($p = 0.007$) and catheter insertion ($p < 0.001$), but not gender ($p = 0.994$) was major determinants for infection.

DISCUSSION

The major complications of venous access ports placement especially in cancer patients scheduling for chemotherapy include infection, thrombosis, and catheter obstruction (14). Among these, related infection is the most common complication that results in device removal. As reported by Fischer et al (15), 46.2% of catheter- port-related are planned for removal due to managing infectious complication. Moreover, the costs of managing these complications and treatment of related bacteremia will be considerably high (16).

Several authors studied the factors that increase the infectious port complications, and one of the most significant factors was the background of malignancy. Samaras et al. (17) reported that the port-associated infections are mostly observed in younger patients with hematologic malignancy, and assumed that intensive chemotherapy and prolonged neutropenia might be responsible for the results. Another recent study showed that outpatient placement of the IVAPs reduced the infection rate (18). Thus, we tried to assess the rate and main determinants of CRBSI among children who suffering malignancies hospitalized in children hospital. First we showed that about one-third of children were planned for chemotherapy port insertion especially in older children. In addition, 18.87% of all patients had blood infection with about four times more in those with catheter as compared to non-catheter subgroup. Moreover, both factors of catheter and age were shown as the main determinants of bacteremia due to catheter. In this study, those with port chemotherapy were more likely to be infected (64%) than those who did not. As mentioned in numerous articles, infection is a major complication of venous port (19). In the present study, there was a significant relationship between age and blood infection, and older children (10 to 19 years) had more infections than younger people (0 to 10 years). There was also a significant relationship between age and outcome. But previous studies have shown that younger age is one of the risk factors for bloodstream infection (20-22). Of course, another study found that there was no meaningful relationship between age and infection, but the author himself believes that such a relationship exists, and considers that no meaningful result is the result of sampling error in his study (23). Few studies have been performed on the relationship between other demographic variables and blood infection. No significant relationship was found between gender and bloodstream infection in the present study. No significant relationship was found in the Jishue study (23) and there was no significant relationship between gender and port and outcome. In several studies, *Staphylococcus coagulase negative* and *Candida* have been identified as the most pathogenic microorganisms and in one study it was observed that Gram-positive bacteria were more likely to cause bloodstream infections (24). In this study, micrococcus was the most common cause of blood infection. Studies have also shown microcosms to be among the major infectious bacteria. There was a significant relationship between port infection and blood infection, and of those with bloodstream infection, about 7% eventually died.

However, few studies have been conducted on the mortality rate of bloodstream infections (25). Although there was no significant relationship between blood infection and outcome in the present study, there was no significant relationship between port and outcome. Few studies have also discussed the relationship between mortality and comorbidity, but many studies have found a significant relationship between infection and port presence. However, most people with ports suffering bloodstream infections were discharged from the hospital (about 97%) and, as mentioned earlier, previous studies have shown that venous ports despite complications such as blood infection can increase quality of life for patients undergoing chemotherapy. Therefore, controlling port complications including infection can be of great help to cancer patients.

ACKNOWLEDGMENT

We are also grateful to staff of the Oncology Department of the Ali Asghar Hospital for their assistance in planning and performing this study. This study is part of MD thesis of Dr Borna Arfaei approved by Iran University of Medical Sciences.

CONFLICT OF INTEREST

No.

REFERENCES

1. Pinelli F, Cecero E, Degl'Innocenti D, Selmi V, Giua R, Villa G, et al. Infection of totally implantable venous access devices: A review of the literature. *The journal of vascular access*. 2018;19(3):230-42.
2. Hormozi S, Vasei, N, Aminianfar M, Darvishi M, Saeedi A. Antibiotic resistance in patients suffering from nosocomial infections in Besat Hospital. *European Journal of Translational Myology*. 2018;28(3):304-308.
3. Beigmohammadi MT, Hussain Khan Z, Samadi S, Mahmoodpoor A, Fotouhi A, Rahimiforushani A, Asadi Gharabaghi M. Role of Hematocrit Concentration on Successful Extubation in Critically Ill Patients in the Intensive Care Units. *Anesth Pain Med*. 2016 Jan 16;6(1):e32904.
4. Lebeaux D, Fernandez-Hidalgo N, Chauhan A, Lee S, Ghigo JM, Almirante B, et al. Management of infections related to totally implantable venous-access ports: challenges and perspectives. *The Lancet Infectious diseases*. 2014;14(2):146-59.
5. Pandey N, Chittams JL, Trerotola SO. Outpatient placement of subcutaneous venous access ports reduces the rate of infection and

- dehiscence compared with inpatient placement. *Journal of vascular and interventional radiology: JVIR*. 2013;24(6):849-54.
6. Sonali Advani NGR, 2 Arnab Sengupta,1 Leslie Gosey,3 and Aaron M. Milstone1. Bloodstream Infection in Hospitalized Children with Peripherally Inserted Central Venous Catheters: Extending unit care intensive the outside risk analyses.
 7. A. Simon UBaKB. Central venous catheter-related complications in children with oncological/hematological diseases: an observational study of 418 devices. Hamburg, Germany. 2005.
 8. Shim J, Seo T-S, Song MG, Cha I-H, Kim JS, Choi CW, et al. Incidence and risk factors of infectious complications related to implantable venous-access ports. *Korean J Radiol*. 2014;15(4):494-500.
 9. Ji L, Yang J, Miao J, Shao Q, Cao Y, Li H. Infections Related to Totally Implantable Venous-Access Ports: Long-Term Experience in One Center. *Cell biochemistry and biophysics*. 2015;72(1):235-40.
 10. Shin YS YH, Lim OR, Park SY, Kim YT, Lee KW. A case of primary ovarian choriocarcinoma. *Korean J Obstet Gynecol* 1994;37:592-596.
 11. Neshler L, Rolston KV. The current spectrum of infection in cancer patients with chemotherapy related neutropenia. *Infection*. 2014;42(1):5-13.
 12. Lebeaux D, Larroque B, Gellen-Dautremer J, Leflon-Guibout V, Dreyer C, Bialek S, et al. Clinical outcome after a totally implantable venous access port-related infection in cancer patients: a prospective study and review of the literature. *Medicine*. 2012;91(6):309-18.
 13. Reboli AC, Rotstein C, Pappas PG, Chapman SW, Kett DH, Kumar D, et al. Anidulafungin versus fluconazole for invasive candidiasis. *The New England journal of medicine*. 2007;356(24):2472-82.
 14. Narducci F, Jean-Laurent M, Boulanger L, El Bédoui S, Mallet Y, Houpeau JL, et al. Totally implantable venous access port systems and risk factors for complications: a one-year prospective study in a cancer centre. *Eur J Surg Oncol*. 2011;37:913-918. [PubMed] [Google Scholar]
 15. Fischer L, Knebel P, Schröder S, Bruckner T, Diener MK, Hennes R, et al. Reasons for explantation of totally implantable access ports: a multivariate analysis of 385 consecutive patients. *Ann Surg Oncol*. 2008;15:1124-1129. [PubMed] [Google Scholar]
 16. Biffi R, de Braud F, Orsi F, Pozzi S, Mauri S, Goldhirsch A, et al. Totally implantable central venous access ports for long-term chemotherapy. A prospective study analyzing complications and costs of 333 devices with a minimum follow-up of 180 days. *Ann Oncol*. 1998;9:767-773. [PubMed] [Google Scholar]
 17. Samaras P, Dold S, Braun J, Kestenholz P, Breitenstein S, Imhof A, et al. Infectious port complications are more frequent in younger patients with hematologic malignancies than in solid tumor patients. *Oncology*. 2008;74:237-244. [PubMed] [Google Scholar]
 18. Pandey N, Chittams JL, Trerotola SO. Outpatient placement of subcutaneous venous access ports reduces the rate of infection and dehiscence compared with inpatient placement. *J Vasc Interv Radiol*. 2013;24:849-854. [PubMed] [Google Scholar]
 19. A. Simon1 UBaKB. Central venous catheter-related complications in children with oncological/hematological diseases: an observational study of 418 devices. Hamburg, Germany. 2005
 20. Pinelli F, Cecero E, Degl'Innocenti D, Selmi V, Giua R, Villa G, et al. Infection of totally implantable venous access devices: A review of the literature. *The journal of vascular access*.
 21. Pandey N, Chittams JL, Trerotola SO. Outpatient placement of subcutaneous venous access ports reduces the rate of infection and dehiscence compared with inpatient placement. *J Vasc Interv Radiol*. 2013;24(6):849-54.
 22. Ji L, Yang J, Miao J, Shao Q, Cao Y, Li H. Infections Related to Totally Implantable Venous-Access Ports: Long-Term Experience in One Center. *Cell biochemistry and biophysics*. 2015;72(1):235-40.
 23. Shin YS YH, Lim OR, Park SY, Kim YT, Lee KW. A case of primary ovarian choriocarcinoma. *Korean J Obstet Gynecol* 1994;37:592-596
 24. Neshler L, Rolston KV. The current spectrum of infection in cancer patients with chemotherapy related neutropenia. *Infection*. 2014;42(1):5-10.
 25. Lebeaux D, Larroque B, Gellen-Dautremer J, Leflon-Guibout V, Dreyer C, Bialek S, et al. Clinical outcome after a totally implantable venous access port-related infection in cancer patients: a prospective study and review of the literature. *Medicine*. 2012;91(6):309-18.