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The Effect of a Guide Based Application Bundle on the Catheter-Related Infection

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ABSTRACT

Aim: Central venous catheters are used extensively in intensive care units but can sometimes lead to catheter related blood stream infections. This study was carried out to determine the effect of guideline-based care bundle on possible catheter-related bloodstream infection in the application and care of central venous catheter in patients receiving follow-up and treatment in anesthesia intensive care unit.

Method: The study is a retrospective and experimental one. The study population consisted of patients who were treated in an anesthesia intensive care unit of a university hospital between June 2015 and June 2016, to whom the central line was inserted in this unit by the team working in the unit and who required central line insertion for at least 48 hours. The patients in the study population also comprised the study sample. The guideline-based application and care bundle was administered under the supervision of the researcher in the intensive care unit and the patients were evaluated on a daily basis for bloodstream infection.

Results: When comparing data obtained from the study with data from the previous period, it was found that the guideline-based application and care bundle decreased the catheter-related bloodstream infection rate from 10.59/1000 to 2.88/1000 and this reduction was considered statistically significant ($p<0.05$).

Conclusion: According to this study's data, the guideline-based care bundle is an effective and useful way to reduce infection.

Keywords: Bundle, care bundle, central venous catheter, infection, intensive care

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INTRODUCTION

Central venous catheters (CVC) is a procedure in which a catheter with various specifications is inserted into a central vein leading directly to the heart (Bell, & O'Grady, 2017; Ergül et al., 2016). CVC can be used for different purposes in each patient.

Although CVC contributes to the improvement of the health status of patients, it can also be the main cause of complications such as Central Line-Associated Blood Stream Infections (CLABSI), hemorrhage and thrombosis. CLABSIs are one of the most important problems experienced in intensive care units and the leading cause of morbidity and mortality (Galpern, Guerrero, Tu, Fahoum & Wise 2008). It is reported that although the CLABSI rate decreased by 46% between 2008 and 2013 in the US, there are still 30000 cases of CLABSI every year (Bell, & O'Grady, 2017). CLABSIs are also the leading cause of morbidity and mortality in the intensive care settings in Turkey. According to the National Nosocomial Infections Surveillance Network (NNISN) report (2014), in Turkey, the ratio of the CLABSI in Anesthesia Reanimation Intensive Care Units to CVC days was 2044/436494 and the weighted mean value was 4.7.

The measures to be taken and the rules to be followed during the placement, use and care of the central line to prevent these infections have been given in detail in international guidelines such as Our Lady's Children's Hospital, Crumlin's (OLCHC) Guideline, Central Venous Access Devices (CVAD) Guidelines, Healthcare Infection Control Practices Advisory (HICPAC) and Centers for Disease Control and Prevention (CDC) Guideline (Healthcare Infection Control Practices Advisory Committee, 2011). Of these guidelines, CDC and HICPAC takes the lead. In the Guidelines, Care Bundles, one of the current approaches towards the patient care and prevention of infections, are emphasized. Care bundles are defined by the Institute for Health Improvement (2012) as 'a small set of evidence-based interventions for a defined patient segment/population and care setting that, when implemented together will result in significantly better patient outcomes than when implemented individually'. Care bundles do not represent the comprehensive care required of a process, their purpose is to test a theory 'when compliance is measured for a core set of accepted elements of care for a clinical process, the necessary teamwork and cooperation required will result in high levels of sustained performance and improved outcomes' (Institute for Healthcare Improvement-IHI, 2012). A care bundle refers to the simultaneous and precise use of interventions as a set each of whose positive contribution to the healing process and outcomes of the healing process has been scientifically proven, to achieve better outcomes than the outcomes when they are used singly (Furuya et al., 2016; Klintworth et al., 2004).

Recently, internationally conducted studies have shown that central line-associated blood stream infections can be prevented by implementing a care bundle (Galpern et al., 2008; Hebbar, Cunnigham, McCracken, Kamat & Fortenberry, 2015; Jeong, Park, Lee, Song & Lee, 2013; Jones 2013; Kim, Holtom & Vigen, 2011; Klintworth et al. 2014). However, in Turkey, two national studies investigating the effect of a care bundle on the prevention of central line-associated blood stream infections have been published (Durak et al.,2014; Polat et al., 2014). In Polat et al.'s study (2014), a care bundle was implemented on a group of patients to whom the central line was inserted in the external diseases services or operating room, and it was observed that the rate of CLABSIs decreased after the implementation, but that the decrease was not statistically significant. In the same study, the care bundle im-

plementation checklist was filled out not by the researcher but by other clinicians. In Durak et al.'s study (2014) aiming to reduce tool-related infections in Turkey by implementing the care bundle, it was determined that the care bundle was not effective in CLABSI. Therefore, in other international and national studies in the literature, it was thought that a study to investigate the effective implementation of a care bundle in the prevention of CLABSIs should be carried out under the supervision of a researcher in accordance with the all or none principle.

This present study was conducted to investigate the effect of the care bundle developed by the CDC and HICPAC on the Central Line-Associated Blood Stream Infection rates in patients to whom a central line was inserted in the anesthesia and reanimation intensive care unit of an Application and Research Hospital.

Hypotesis

Hypotesis 1

H 0: The use of a care bundle developed by CDC and HICPAC has no effect on the development of CLABSI when the CVC is opened to patients treated in intensive care.

H 1: The use of a care bundle developed by CDC and HICPAC has an effect on the development of CLABSI when the CVC is opened to patients treated in intensive care.

Hypotesis 2

H 0: The use of a care bundle developed by CDC and HICPAC in the treatment of CVC in patients who were treated in ICU and who were treated with CVC had no effect on the development of CLABSI in the patient.

H 1: The use of a care bundle developed by CDC and HICPAC in the treatment of CVC in patients who were treated in ICU and who were treated with CVC had an effect on the development of CLABSI in the patient.

METHOD

Study Design

This retrospective and quasi-experimental study was conducted in the anesthesiology and reanimation intensive care unit of a university hospital. The Anesthesia and Reanimation Intensive Care Unit has 25-bed capacity. In the unit, 9 physician assistants and 32 nurses work. The central line is inserted by a physician assistant, and a nurse performs the care of the insertion site of the central line using povidone iodine. The presence of infection in the central line is checked by nurses during care.

Sample

The study population consisted of patients who were treated in an anesthesia intensive care unit of a university hospital between June 2015 and June 2016, to whom the central line was inserted in this unit by the team working in the unit and who required central line insertion for at least 48 hours. The patients in the study population also comprised the study sample. Patients who were pregnant, transferred from another unit or center to the anesthesia intensive care unit with central line, or previously diagnosed with CLABSI, or in whom central line were inserted or central line care were given beyond the researcher's knowledge were excluded from the study. During the 6-month study period, 218 patients were reached and according to the inclusion and exclusion criteria of the study only 58 patients were included in the study group. 62 patients were evaluated between the dates indicated in the study and 4 of these patients were excluded from the study due to death.

Data Collection

The following three tools developed by the researcher were used to collect data: "The Care Bundle Checklist for the Prevention of CLABSI

in Patients with a Central Line Inserted", "the Daily Evaluation Form of Patients with a Central Line", and "the 6-Month Data Checklist Regarding the CLABSI" prepared by the Infection Control Committee.

The first tool is an application tool which includes 6 main and 5 sub-items questioning the appropriate hand hygiene, maximum barrier precautions, appropriate central line site selection, skin antisepsis with chlorhexidine, and compliance with aseptic techniques when central lines are inserted and post-administration hand hygiene all of which recommended by the CDC and HICPAC. This tool also questions sociodemographic characteristics of the participants. The second tool including 10 main and 5 sub-items questions the following: the duration of the infusion set if the patient has one, whether or not blood transfusion has been performed, whether the unused lumens are closed, whether central line dressing care has been performed, whether the hubs have been cleaned with alcohol before the medication is put in the sets, the kinds and number of blood products received through the central catheter, the amount of parenteral nutrition, assessment of daily need for the central line for the hemodialysis therapy, removal of the central line if it is not needed, whether there are local infections in the catheter area. The third tool is "the 6-Month Data Checklist Regarding the CLABSI" prepared by the Infection Control Committee. The tool has 6 items which question the number of central line insertions, the number of CVC days, CLABSI rate, the number of patient days, the number of patients, and the incidence of CLABSIs.

The 6-month retrospective data from the beginning date of the study on the number of central line insertions, the number of CVC days, CLABSI rate, the number of patient days, the number of patients, and the incidence of CLABSIs were obtained from the Infection Control Committee of the University Hospital. The Infection Control Committee makes the diagnosis of CLABSI based on the Blood Stream Infections diagnostic criteria verified by the CDC's laboratory in patients having infection signs and symptoms. These three tools were filled out by the researcher every day for 6 months.

At the beginning of the study, a 30-minute meeting was held with the clinical staff including the nurses and physician assistants in a classroom in the Anesthesiology Intensive Care Unit to improve their compliance with the care bundle. This meeting was held by the researcher, in direct instruction tecnique and in a one session. There were no health personnel who did not want to participate in the meeting.

The meeting was later repeated several times with the same participants and the other health personnel joined them during the study. At the meetings, the participants were informed about the care bundle defined in the guidelines, as well as its aim and importance. It was emphasized that if compliance with even one of the five strategies listed in the guidelines was not performed, no positive effects could be obtained from the patients' infection-related outcomes since the full compliance with the bundle was not achieved. The main objective of these meetings was to ensure the team's compliance with the bundle by enabling them to act together with the researcher.

Another action taken by the researcher during the study process to increase the compliance with the care bundle was to observe and support the physicians' compliance with the aseptic techniques while they inserted the central line to the 58 patients. The fact that physicians did not fully comply with the aseptic techniques during the insertion of the central line in previous clinical observations made it necessary for the researcher to display such an approach during the study.

In the study process, another important application regarding the compliance with the care bundle was the use of chlorhexidine instead of povidone iodine in central line dressings. Dressings were changed by the researcher every other day, and the central line insertion sites of the patients were evaluated and recorded for infection symptoms.

Statistical Analysis

The data obtained were analyzed using the IBM Statistical Package for Social Sciences v.22 (IBM SPSS Corp.; Armonk, NY, USA). The data on patients' sociodemographic characteristics were given in numbers and percentages. Quantitative data were calculated as median. Because the parametric test assumptions were not met (Kolmogorov Simirnov), the Mann-Whitney U test was used to compare two independent groups, and the Fisher exact chi-square test was used to compare the qualitative data. The error margin was accepted as 0.05.

The incidence of CLABSI was calculated as the 'rate of CLABSI'. This numerical value calculated refers to the number of infections developed during the use of a central line, and the duration of central line use is calculated as 1000 catheter days.

$$\text{CLABSI rate} = \frac{\text{the number of central line–associated blood stream infections}}{\text{CVC–days}}$$

The CVC-days refer to the number of the days during which the patients staying in the clinic had central lines during the period they underwent treatment. The rate of central line use refers to the ratio of the number of the days patients have the central line to the number of patient days in the intensive care unit.

$$\text{The rate of central line use} = \frac{\text{the number of CVC–days}}{\text{the number of patient days}}$$

The number of patient days refers to the number of the days when all patients with or without central line stay in the clinic for a certain period of time.

Ethical Considerations

Before the study was conducted, the ethics committee approval was obtained from the Non-Interventional Clinical Research Ethics Committee of Cumhuriyet University and the written permission was obtained from the hospital where the study was to be conducted. The study was conducted in accordance with the Declaration of Helsinki. If the patient was conscious, the patient, if not, his/her relatives were informed of the implementation and its results, and then their informed consent was obtained.

RESULTS

Of the participants, 53.4% were female. In the present study, CLABSI were detected in 2 (6.45%) of the 31 female patients and 2 (7.40%) of 27 male patients. There was no statistically significant difference between the central line-associated blood stream infection rates in terms of gender ($p>0.05$). The analysis of the patients' ages, length of intensive care stay, duration of central line use, and whether the service length of the physician inserting the CVC affected the development of CLABSI revealed that the mean age of the patients who developed CLABSI was 76 ± 2.44, whereas the mean age of the patients who did not develop CLABSI was 73.4 ± 10.59, and that the difference between them was not statistically significant ($Z=0.323$, $p>0.05$) (Table 1).

While the mean length of hospital stay in 4 patients who developed CLABSI was 142 ± 62.70 days, it was 29.74 ± 4.26 days in 54 patients who did not develop CLABSI. Similar to this finding, although the mean of the retention days of central line in the patients with CLABSI was 70.5 ± 7.6, it was 20.4 ± 3.15 in the patients without CLABSI. The difference between the patients with and without CLABSI in terms of

the mean length of stay in intensive care unit (Z=2.794; p=0.005) and the mean of the retention days of central line (Z=2.922; p<0.05) was statistically significant (Table 1).

The mean service length of the physicians inserting the central line to the patients with CLABSI was 1.5±0.28 years whereas it was 2.25±0.11 years in the physicians inserting the central line to the patients without CLABSI. However, the difference between them was not statistically significant (Z=1.766; p>0.05) (Table 1).

The patients were classified into three groups in terms of receiving a special treatment: (1) those who received Total Parenteral Nutrition (TPN), (2) those who received hemodialysis treatment and (3) those who received neither treatment. When the patients in these 3 groups were analyzed in terms of developing CLABSI, the rate was 10.52%, 14.28% and 3.12% respectively in those with CLABSI, and 89.47%, 85.71% and 96.88% respectively in those without CLABSI. The difference between the three

Table 1. Distribution of developmental conditions in the CLABSI

	CLABSI		
	Existent (n=4)	**Absent (n=54)**	**Data Analysis**
Age of patients (year)	76±2.44	73.4±10.59	Z=0.323
			p=0.747
Length of intensive care stay	142±62.70	29.74±4.26	Z=2.794
			p=0.005
Duration of central line use	70.5±7.60	20.4±3.15	Z=2.922
			p=0.003
Whether the service length of the physician inserting the CVC	1.5±0.28	2.25±0.11	Z=1.766
			p=0.077
TPN treatment	2 (% 10.52)	17 (% 89.47)	p=0.591
Hemodialysis treatment	1 (% 14.28)	6 (% 85.71)	p=0.411
Those who do not receive TPN or Hemodialysis treatment	1 (%3.12)	31(%96.87)	p=0.747

CLABSI: central line-associated blood stream infections; CVC: central venous catheters; TPN: total parenteral nutrition

Table 2. Distribution of data related to central venous catheter related to research during the ımplementation period of the study according to previous periodicals

	June-December 2015 (Routine Application)	**December-June 2016 (Bundle Application)**	**Data Analysis**
Total Number of Patients (n)	264	58	
Patient's Day	4215	2174	
Central Venous Catheter Day (n)	3116	1387	
Central Venous Catheter Utilization Rate	0.74	0.67	t=0.23
			p=0.765
Catheter Related Blood Stream Infections (n)	33	4	
Catheter Related Blood Stream Infections Rate	10.59/1000	2.88/1000	t=11.01
			p=0.001

groups in terms of developing CLABSI was statistically insignificant (p>0.05) (Table 1).

Of the maximum barrier measures, mask compliance was not achieved by the physicians in 2 of the 58 patients who were subjected to care bundle in the study, and hand hygiene was not performed by the physician who inserted the central line in 1 patient. After the researcher warned the physicians, they complied with the care bundle.

While the total number of patients in the intensive care unit with central lines was 218 in the study period, it was 264 in the previous period. The comparison of the patient days during the two periods demonstrated that the number of the patient days was 3982 during the study period and 4215 during the previous period.

Based on the data obtained from the Hospital Infection Control Committee, in the intensive care unit during the 6-month period before the study, central venous catheter use was 4215 catheter days, central venous catheter rate was 0.74 and the ratio of the CLABSI to catheter days was 10.59/1000 catheter days. During the six months of the study period, 58 patients who met the inclusion criteria were included in the study. In these patients, the central venous catheter use was 1387 catheter days, central venous catheter rate was 0.67 and the ratio of the CLABSI to catheter days was 2.88/1000 catheter days (Table 2). Of the patients included in the study, four (6.89%) developed CLABSI. The CLABSI rate determined in the study period was statistically significantly lower than that determined in the 6-month period prior to the study, (t=11.01; p<0.05) (Table 2).

DISCUSSION

The comparison of the data on CLABSIs developed by the patients participating in the present study obtained during the study period with those of the previous period revealed that the number of cases developing CLABSIs decreased from 33 to 4, and the ratio of the CLABSIs to CVC days decreased from 10.59/1000 catheter days to 2.88/1000 catheter days, which was statistically significant (t=11.01, p=0.001). A study investigating the relationship between CLABSIs and the central line care bundle obtained results similar to the results of the present study. In that study, during the 24-month period which included 1395 central lines and 9938 CVC days, the mean of the CVC days decreased from 8.5±1.3 to 6.8±0.97 and the mean of the CLABSI days decreased from 5.0±4.3 to 0.90±1.3 (p<0.001) (Galpern et al., 2008). In Apisarnthsnarak, Thongphubet, Yuekyen, Warren & Fraser's 3-year study (2009), no CLABSIs occurred in the third 6th-month period of the study, and when compared with the first period, the mean of the CVC days decreased significantly (4.9±1.5 days) in the second period (p<0.001).

In present study, this decline in the CLABSI rate could be explained by the fact that within the scope of the care bundle, in the present study, chlorhexidine was used for the catheterization and central line care instead of povidone iodine which was routinely used in the intensive care unit before the study, and that the researcher observed and supported the physicians' compliance with the aseptic techniques while they inserted the central line to the 58 patients. In addition, it can be said that this significant decrease was also influenced by the meetings at which compliance with the care bundle was emphasized.

The analysis of the development of CLABSIs by gender demonstrated that there was no statistically significant difference between men and women. However, in their study on the development of CLABSIs, O'Neil et al. (2016) reported that the rate of development of CLABSIs was higher in men than in women (p=0.031).

As the length of stay in hospital and duration of central line use increase so does the risk of developing CLABSI (Guerin, Wagner, Rains & Bessesen, 2010; Mehndiratta, Nayak, Ali & Sharma, 2016; Polat et al. 2014). In the current study, it was determined that as the length of hospital stay increased, so did the rate of development of CLABSIs and that there was a statistically significant relationship between these two variables (Z=2.794, p=0.005). Mehndiratta et al. (2016) demonstrated that the incidence of CLABSIs increased significantly as the duration of central line use increased (p=0.0072). In their study, Guerin et al. (2010) reported that the patients developed an infection on average of 12 days after the insertion of the central line. CLABSIs increase the length of stay in the hospital by about 12 days (between 4.5 and 19.5 days) and the average cost for each patient by $ 18.432 (between $3.59 and $34.410) (Jones, 2013). Therefore, in order to avoid the development of CLABSIs, it is vital to shorten the duration of central line use as much as possible.

In the present study, it was found that although the CLABSI development rate was lower in the patients who did not receive a special treatment through the central line (3.12%), the rate was higher in the patients who received TPN (10.52%) or in patients who underwent hemodialysis treatment (14.28%). However, there was no statistically significant difference between these rates due to the small size of the sample (p>0.05). On the other hand, in Hakyemez, Yıldırmak, Çetmeli & İris's study (2016), the patients receiving TPN developed statistically significantly more infections (p=0.003).

CONCLUSION AND RECOMMENDATIONS

Central line is a widely used tool in the observation and treatment of patients in intensive care units. These catheters, which serve many purposes, increase the risk of morbidity and mortality in the patient due to CLABSIs, and can cause significant problems by increasing the length and cost of hospital stays. CLABSIs whose treatment is costly.

In this 6-month study, the rate of CLABSIs was reduced by implementing the CVC care bundle recommended by the CDC and HICPAC, and the decrease was statistically significant. It was determined that gender and age did not affect the development of CLABSIs. However, an increase in the length of stay in hospital and duration of central line use increased the rate of CLABSIs. It was also determined that the administration of TPN and implementation of hemodialysis through the central line increased the rate of CLABSIs, but did not lead to a statistically significant difference.

Similar to the present study, studies in the literature were not randomized controlled studies. Therefore, we recommend that future studies should include a randomized control group, and that care bundles should be implemented in both intensive care settings and throughout the country.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Cumhuriyet University (Date: 02.07.2015, Reference Number: 2015-07/04).

Informed Consent: Written informed consent was obtained from his/her relatives who participated in this study.

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References

Apisarnthsnarak, A, Thongphubet, K, Yuekyen, C, Warren, D. K., & Fraser V. J. (2009). Effectiveness of a catheter-associated bloodstream infection bundle in a Thai tertiary care center: A 3-year study. *American Journal of Infection Control, 38*(6), 449-455. [CrossRef]

Bell, T., & O'Grady, N. P. (2017). Prevention of Central Line-associated Bloodstream Infections. *Infectious Disease Clinics of North America, 31*(3), 551-559. [CrossRef]

Centers for Disease Control and Prevention Healthcare-associated Infections in the United States, 2006-2016: A Story of Progress. (2018, 2 January). Retrieved from https://www.cdc.gov/hai/surveillance/data-reports/data-summary-assessing-progress.html

Durak, U., Yüce, S., Tayran, N., Tiryaki, S., Durak, Z., & Koka, A., et al. (2014). Efforts to prevent pediatric intensive care infections by applying bundle methods. *Turkish Archives of Pediatrics, 49*(1), 9-10.

Ergül, B., Özcan, A., Aslaner, H., Aslaner, H. A., Köse, S., & Torun-Altuner, Y. (2016). Evaluation of central venous catheterization complications and related risk factors in a pediatric intensive care unit. *Turkish Journal of Intensive Care Medicine, 7*, 9-14. [CrossRef]

Furuya, Y. E., Dick, A. W., Herzig, C. T. A., Pogorzelska-Maziarz, M., Larson, E. L., & Stone, P. W. (2016). Central line-associated bloodstream infection reduction and bundle compliance in intensive care units: A National Study. *Infection Control & Hospital Epidemiology, 37*(7), 806-810. [CrossRef]

Galpern, D., Guerrero, A., Tu, A., Fahoum, B., & Wise, L. (2008). Effectiveness of central line bundle campaign on line-associated infections in the intensive care unit. *Surgery, 144*(4), 492-495. [CrossRef]

Guerin, K., Wagner, J., Rains, K., & Bessesen, M. (2010). Reduction in central line-associated bloodstream infecions by implementation of a postinsertion care bundle. *American Journal of Infection Control, 38*(6), 430-433. [CrossRef]

Healthcare Infection Control Practices Advisory Committee. (2011) Guidelines for the Prevention of Intravascular Catheter-Related Infections. Retrieved from https://www.cdc.gov/infectioncontrol/pdf/guidelines/bsi-guidelines-H.pdf

Hakyemez, İ. N., Yıldırmak, M. T., Çetmeli, G., & Iris, N. E. (2016). Prevelance, causative microorganisms, and risk factors of central venous catheter-related infections in a tertiary care hospital. *Abant Medical Journal*, 5(2), 108-117. [CrossRef]

Hebbar, K. B., Cunnigham, C., McCracken, C., Kamat, P., & Fortenberry, J. D. (2015). Simulation-based paediatric intensive care unit central venous line maintenance bundle training. *Intensive and Critical Care Nursing*, 31(1), 44-50. [CrossRef]

Institute for Healthcare Improvement (IHI). (2015, 24 November) Implement the central line bundle. Retrieved from http://www.ihi.org/IHI/Topics/CriticalCare/IntensiveCare/Changes/ImplementtheCentralLineBundle.

Jeong, I. S., Park, S. M., Lee, J. M., Song, J. Y., & Lee, S. J. (2013). Effect of central line bundle on central line-associated bloodstream infections in intensive care units. *American Journal of Infection Control, 41*(8), 710-716. [CrossRef]

Jones, C. A. (2013). Haemodialysis central venous catheter care bundle to reduce MRSA. *Journal of Renal Nursing, 5*(4), 189-194. [CrossRef]

Kim, J. S., Holtom, P., & Vigen, C. (2011). Reduction of catheter-related bloodstream infections through the use of a central venous line bundle: Epidemiologic and economic consequences. *Association for Professionals in Infection Control and Epidemiology, 39*(8), 640-646. [CrossRef]

Klintworth, G., Stafford, J., O'Connor, M., Leong, T., Hamley, L., Watson, K., et al. (2014). Beyond the intensive care unit bundle: Implementation of a successful hospital-wide initiative to reduce central line-associated bloodstream infections. *American Journal of Infection Control, 42*(6), 685-687. [CrossRef]

Mehndiratta, M. M., Nayak, R., Ali, S., & Sharma, A. (2016). Bloodstream infections in NNICU: Blight on ICU stay. *Ann Indian Acad Neurol, 19*(3), 327-331. [CrossRef]

National Nosocomial Infections Surveillance Network (NNISN) report, 2014. (2018, 28 January) http://dosyamerkez.saglik.gov.tr/Eklenti/2815,2014-ulusal-ozet-rapor-1pdf.pdf?0

O'Neil, C., Ball, K., Wood, H., McMullen, K., Kremer, P., Jafarzadeh, S. R., et al. (2016). A central line care maintenance bundle for the prevention of central line-associated bloodstream infection in Non-Intensive Care Unit settings. *Infection Control & Hospital Epidemiology, 37*(6), 692-698. [CrossRef]

Polat, F., Şahinoğlu, A. H., Dilek, A., Köksal, E., Üstün, Y. B., Kaya, C., et al. (2014). The effect of care bundles based on guidelines over the central venous catheter infections in an intensive care unit. *Turk J Intense Care, 12*, 86-93. [CrossRef]