MOSUL JOURNAL OF NURSING
Online ISSN: 2663-0311 - Print ISSN: 2311-8784
Website: https://mjn.mosuljournals.com

RESEARCH ARTICLE

DELAYED COMPLICATIONS OF CENTRAL VENOUS CATHETER IN PATIENTS UNDERWENT BONE MARROW TRANSPLANTATION IN SULAIMANI CITY/IRAQ

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ABSTRACT
Background: Central venous catheter is essential in the management of patients undergoing bone marrow transplants, however, insertion of it has often the potential of inducing major complications.

Aim: The aim of the study was to assess central venous catheter-related complications in patients underwent bone marrow transplants.

Methodology: A retrospective study was carried out at Shahid Shaswary Garmian for bone marrow transplantation in Sulaimani City on 112 adult patients who underwent bone marrow transplants from June 2016 to May 2021. The patient's medical records were used to collect data regarding; patients' and CVCs characteristics, intravenous infusions, CVC-related complications; the number and type of complication.

Results: The age of 52.7% was between 40-60 years, most of them were male, primary school, and from urban. The medical diagnosis for (43.8%) was multiple myeloma, majority underwent autologous transplant, Hickman line was used for 48.2%, internal jugular vein was a most used vein, the length of stay with a catheter for almost 70% was between 2 to 3 weeks, and the majority had 2 dressing per week, most of the participants received 2 bags of Fresenius, 51.8% received blood, and 92% received platelet. The catheter-related complications occurred in 65.2% of participants, the number and type of complications were varied; 42% had one, 19.6% two, and 3.6% three complications, the proportion of fibrin was 42.9% followed by infection 32.1, occlusion 10.7%, and hematoma 7.1%. The incidence of complications was higher in leukemic patients, who had allogeneic transplants and used Hickman line 88.9%. In addition, using internal jugular vein for insertion 90%, long stay with the catheter (≥ 4 weeks) 89.3% and fewer number of dressing (1 dressing/week) 100% were more problematic.

Conclusions: The incidence of central venous catheter-related complications was high, almost two-thirds had at least one complication. The most common complications were fibrin and infection. The incidence of complications affects by patients' medical diagnosis, type of transplant and catheter, vein used for insertion of the catheter, the duration of stay with a catheter, and the number of dressings for catheters sit.

Keywords: Complications, Bone Marrow, Central venous catheter

Received: 21 October 2021, Accepted: 06 December 2021, Available online: 20 January 2022

INTRODUCTION

Bone marrow transplantation (BMT) is currently considered as a practiced and a well-established modality for the treatment of several hematological diseases and malignancies. Central venous catheters (CVCs) have a crucial role in patients who are undergoing such therapeutic procedure. Their insertions could be effectively used in the infusion of chemotherapeutic drugs, stem cells, blood products, electrolyte supplements, antibiotics, and frequent venous samplings (Elgendy, et al, 2020). On other hand, CVCs represent an important target of investigation in the effort to improve patient safety and quality outcomes, particularly with respect to decreasing complication rates associated with the use of this necessary but invasive medical device (Bell et al, 2020).

Patients undergoing bone marrow transplantation require long-term venous access for the administration of medication, blood products, parenteral hyperalimentation and for blood sampling. Central venous catheters with a single, double or triple lumen, mostly Hickman catheters, are used. However, one of the major complications of these CVCs is catheter-associated infections, with a reported incidence varying between 42.5% and 50.6%. Another complication is thrombosis of the major veins of the thorax. (Barreta et al, 2016).

Central venous catheters (CVCs) are frequently used to treat hematologic malignancies. Their use is critical for safe and convenient venous access for blood sampling, drug infusions, supportive intravenous treatments, blood product administration, and parenteral nutrition throughout the course of the disease; additionally, CVC are beneficial for certain therapeutic procedures, such as stem cell collection and apheresis. (Morano et al, 2014).

However, CVC is frequently associated with a number of complications, including device malfunction and/or greater patient morbidity related with longer hospital stays and more expensive medical care. Complications associated with CVCs can be classified as early (mechanical and infectious) or late (mechanical, infectious, and thrombotic); early complications are typically associated with the insertion procedures, whereas late complications are more frequently associated with malpractice in CVC management during follow-up (Patel et al, 2019).

Moreover, CVCs are frequently used in critical care units, hemodialysis units, and oncology units for the administration of intravenous fluids, medications, blood products, parenteral nutrition, vasoactive medications, hemodialysis, and hemodynamic monitoring. Unfortunately, the presence of indwelling CVCs increases the risk of the formation of thrombi, emboli, and infection than patients with peripheral catheters by 200% (Lee et al, 2018).

Furthermore, when complications of central venous catheters occur, they cause significant morbidity, increase length of hospital stay, and delay recovery. The relative cost of central line care interventions (increases in nursing care hours, relatively cheap dispensable, and change to monitoring practices) compared to the morbidity of a CVC-associated infection and the cost of the care for these complications. Many of the complications of CVCs can have chronic health impacts, may affect the patient's suitability for further treatments and procedures, and can increase the risk of future health issues (Muslim et al 2017).

Handling and monitoring CVC is a very important and responsible aspect of the nurses' work. The complications can be prevented by high-quality nursing care. Most nurses care for the CVC, while they are not aware of the standard guideline of Centers for Disease Control and Prevention (CDC). Therefore, nurses might not follow evidence-based practice during CVC care (Muslim et al 2017). Therefore, the aim of current study was to assess central venous catheter-related complications in patients underwent bone marrow transplants in Sulaimani City/Iraq.

METHOD

Exploratory and retrospective study with a quantitative approach, performed in the Shahid Shaswary Garmian Hospital which is the only Bone Marrow Transplantation Hospital in Iraq, with a sample of 112 adult patients, out of 217 patients transplanted, selected by means of medical records and CVC control form, from June 2016 to May 2021.

Inclusion criteria were: medical records of adult patients who underwent BMT and information regarding catheter and CVCs-related complication files that were fully completed, used by the nursing service, and containing patient characteristics, medical diagnosis, type of transplant, catheter model, number of the lumen, insertion vein used, date of implant and removal, as well as the numbers of inserted site dressing. In addition to type and number of intravenous therapies; such as blood and platelet transfusion, and the number of Fresenius bags.

The data were collected through constructed questionnaires by the researcher according to patients' medical records and CVCs-related forms through the process of patients' medical records. Out of 217 patients, records who underwent BMT

112 files were reviewed, 64 files were children and the medical records of 41 patients were not complete thus excluded from the study.

Descriptive statistics were used to describe categorized data and inferential statistics to find out relationships between study's variables; chi-square was used for categorized data and F-test and t-test for continuo data. Social Package of social Science version (25) for window was use.

Statistical analysis

The collected data were compiled and analysed using percentages, mean, median, and Chi-square tests using SPSS version 20. P values of 0.05 were used as a cut-off point for the significance of the statistical test.

RESULTS

One hundred and twelves patients underwent BMT recruited to present retrospective study to find out the occurrence of CVC-related complications.

Mean ± standard deviation of participants' age was 42.8 ± 12.4, the age of more than half (52.7%) was between 40 to 60 years old, nearly two-thirds (62.5%) were male, most of them were low educated either illiterate (14.3%) or primary school graduate (39.2%), majority were from urban as presented in Table 1.

Table (2) demonstrates that the most (43.8%) of participants have Multiple Myeloma, nearly one-fifth had Hodgkin Lymphoma, Acute Myeloid Leukemia (21.4%) and (19.6%) respectively, nearly one-tenth (10.7%) had Non-Hodgkin Lymphoma, and few of them (4.5%) had Acute Lymphoid Leukemia. The type of transplant for the majority (75.9%) of participants was an autologous transplant. Regarding the type of CVCs; the Hickman line was used for almost half (48.2%) of participants. The proportion of PICC line catheters was (42.9%) and the Port line catheter was used for less than one ten (8.9%). The internal jugular vein was used for insertion of the catheter for more than one-third (35.7%), basilic vein for (32.1%), subclavian vein for (21.4%), and the brachial vein was used for (10.7%). More than half (58.0%) of catheters were single lumen. Furthermore, the length of stay with a catheter for (67.9%) was between 2 to 3 weeks, while it was (7.1%) for 4 and more weeks. Regarding the number of dressings performed for catheter insertion sites per week was twice for more than three-quarters (75.9%).

More than two-thirds (68.8%) of participants received 2 bags of Fresenius (hematopoietic stem cell), (13.4%) of them received three bags, almost one-tenth (9.8%) were received one bag only, and (8.0%) were received 4 bags. More than half (51.8%) had a blood transfusion and the majority (92.0%) had platelet infusion through the catheter, as illustrated in Table (3).

The main objective of the study is illustrated as a figure and shows that almost two-thirds (65.2%) of participants had CVC-related complications.

Almost thirty-five percent of patients had no CVC-related complication, most (42.0%) had one complication, the proportion of those who had 2 complications was (19.6%) and (3.6%) of participants had 3 CVC-related complications, as illustrated in Figure 2.

As presented in Table (4) the incidence of fibrin was higher than other complications and it was (57.1%), Infection was second, (32.1%) of participants complained of CVC-related infection. Nearly one-tenth had occlusion and the proportion of hematoma around the CVC insertion site was (7.1%).

Table (5) shows an association between participants' socio-demographic characteristics and occurrence of CVC-related complications, according to the results no association was found, the p-value was greater than 0.05.

The incidence of CVC-related complications was higher significantly in patients with Leukemia; Acute Lymphoid Leukemia (100%) and Acute Myeloid Leukemia (86.4%) when compared to other medical diagnoses as presented in Table (6). The occurrence of CVC-related complications was higher (88.9%) in patients who had Allogeneic bone marrow transplants than patients with Autologous bone marrow transplants (57.6%). Moreover, it was higher in Hickman Line Catheter (88.9%) than PCC Line and Port Line (47.9%) and (20.0%) respectively. The CVC-related complication was double (90.0%) in the internal jugular vein when compared to other veins such as the Basilic vein, Brachial vein, and Subclavian vein (47.2%), (50.0%) and (48.3%) respectively.

Furthermore, the occurrence of complications was higher (74.5%) in Double lumens catheters than single lumen (58.5%), while the difference was not significant statistically ($p > 0.05$). The occurrence of catheter-related complications increased with increasing the length of stay of the catheter. The proportion of CVC-related completions was (89.3%) in patients who had CVC for 4 and more weeks, while it was (55.3%) in patients who had it for less than 3 weeks. On another hand, the number of dressings performed for catheter insertion site associated with the occurrence of complications, the patients who had one dressing per week had a higher proportion of complications (100%) compared to those who

had twice and three-time dressings per week, (13.3%) and (69.4%) respectively.

Table (1) Distribution of sample according to socio-demographic characteristics

Characteristics	Frequency (112)	%
Age Groups / years		
19 – 39	44	**39.3**
40 – 60	59	**52.7**
> 60	9	**8.0**
Mean ± SD	**42.8 ± 12.4**	
Gender		
Female	42	**37.5**
Male	70	**62.5**
Levels of Education		
Illiterate	16	**14.3**
Primary	44	**39.2**
Secondary	21	**18.8**
Institute/University	31	**27.7**
Residency		
Rural	5	**4.5**
Sub urban	27	**24.1**
Urban	80	**71.4**
Total	112	**100**

Table (2) Distribution of sample according to clinical characteristics

Characteristics	Frequency	%
Medical Diagnosis		
Acute Myeloid Leukemia	22	19.6
Acute Lymphoid Leukemia	5	4.5
Hodgkin Lymphoma	24	21.4
Multiple Myeloma	49	43.8
Non-Hodgkin Lymphoma	12	10.7
Type of Transplant		
Allogeneic	27	24.1
Autologous	85	75.9
Type of central venous catheters (CVCs)		
Hickman line	54	48.2
PICC line	48	42.9
Port line	10	8.9
Type of Vein		
Basilic vein	36	32.1
Brachial vein	12	10.7
Internal jugular vein	40	35.7
Subclavian vein	24	21.4
Number of lumens		
Single lumen	65	58.0
Double lumen	47	42.0
Length of stay with catheter		
2 < 3 Weeks	76	67.9
3 < 4 Weeks	26	25.0
≥ 4 Weeks	8	7.1
Number of Dressing / weeks		
One	15	13.4
Two	85	75.9
Three	12	10.7
Total	**112**	**100**

Table (3) Distribution of the Type of Transfusion Through Central Venous Catheter

Type of Transfusion	Frequency	%
Number of Fresenius (hematopoietic stem cell) bags		
One bag	11	**9.8**
Two bags	77	**68.8**
Three bags	15	**13.4**
Four bags	9	**8.0**
Blood Transfusion		
No	54	**48.2**
Yes	58	**51.8**
Platelet Transfusion		
No	9	**8.0**
Yes	103	**92.0**
Total	112	**100**

Table 4 Distribution of the types of CVC-related Complications

Types of Complications	Frequency	%
Infection		
No	76	**67.9**
Yes	36	**32.1**
Fibrin		
No	64	**57.1**
Yes	48	**42.9**
Hematoma		
No	104	**92.9**
Yes	8	**7.1**
Occlusion		
No	100	**89.3**
Yes	12	**10.7**
Total	112	**100**

Table (5) Association between participants' socio-demographic characteristics and occurrence of CVC- related complications

Socio-demographic Characteristics	CVC-related complication					
	No		Yes		Chi-Square	p-Value
	F	%	F	%		
Age Group / Years						
19 – 49	13	29.5	31	70.5	0.999	**0.607**
40 – 60	23	39.0	36	61.0		
> 60	3	33.3	6	66.7		
Gender						
Female	14	33.3	28	66.7	0.066	**0.798**
Male	25	35.7	45	64.3		
Levels of Educations						
Illiterate	5	31.3	11	66.8	6.037	**0.110**
Primary	10	22.7	34	77.3		
Secondary	9	42.9	12	57.1		
Institute / University	15	48.4	16	51.6		
Residency						
Rural	1	20	4	80	1.969	**0.374**
Sub-urban	7	25.9	20	74.1		
Urban	31	38.8	49	61.2		

Table (6) Association between participants' clinical characteristics and occurrence of CVC- related complications

Clinical Characteristics	CVC Line related complication					
	No		Yes		Chi-Square	p-Value
	F	%	F	%		
Medical Diagnosis						
Acute Myeloid Leukemia	3	13.6	19	86.4	9.837	0.043
Acute Lymphoid Leukemia	0	0.0	5	100		
Hodgkin Lymphoma	11	45.8	13	54.2		
Multiple Myeloma	18	38.3	31	61.7		
Non-Hodgkin Lymphoma	7	50.0	7	50.0		

Types of Transplants						
Allogeneic	3	11.1	24	88.9	8.812	0.003
Autologous	36	42.4	49	57.6		
Types of CVC Line						
Hickman Line	6	11.1	48	88.9	28.671	0.000
PCC Line	25	52.1	23	47.9		
Port Line	8	80.0	2	20.0		
Insertion Veins						
Basilic vein	19	52.8	17	47.2	17.686	0.001
Brachial vein	6	50.0	6	50.0		
Internal jugular vein	4	10.0	36	90.0		
Subclavian vein	10	41.7	14	48.3		
Number of Lumen						
Single lumen	27	41.5	38	58.5	3.079	0.079
Double lumen	12	25.5	35	74.5		
Length of stay with catheter						
2 < 3 weeks	34	44.7	42	55.3	12.199	0.002
3 < 4 weeks	3	10.7	6	75.0		
≥ 4 weeks	2	25.0	25	89.3		
Number of Dressing / Week						
One	13	86.7	2	13.3	24.847	0.0001
Two	26	30.6	59	69.4		
Three	0	0.0	2	100		

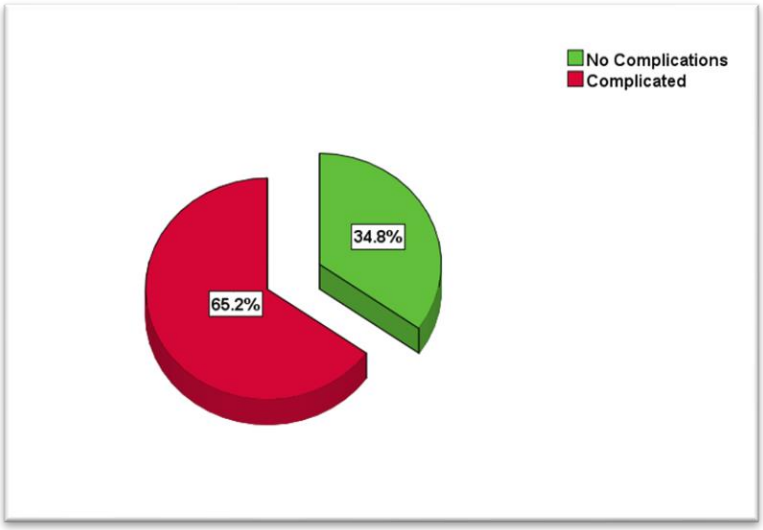

Figure 1 Proportion of CVC-related Complications

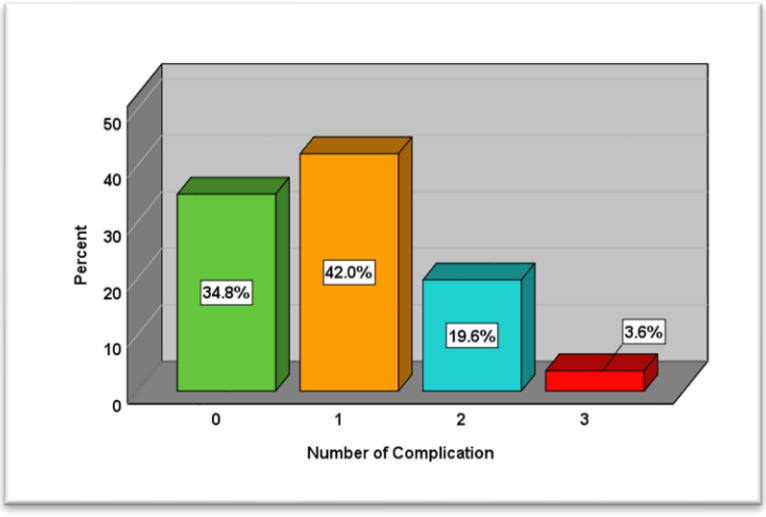

Figure 2 Number of CVC-related complications

DISCUSSION

The analysis of the socio-demographic variables of the patients recruited in this study showed that the age of more than half was between 40 – 60 years old, most were male, more than one-third were primary school graduates, and almost all were from urban.

On other hand, the most medical diagnosis was multiple myeloma, followed by Hodgkin lymphoma, and acute myeloid leukemia, while the proportion of non-Hodgkin lymphoma and acute lymphoid leukemia was about ten and four percent respectively. The type of transplant for almost three-quarters was autologous. Hickman and peripheral insert central (PICC) with single lumen were the most used catheter type.

Moreover, the Internal jugular and basilic were the most used veins for catheter insertion. Furthermore, the length of stay with the catheter was 2 to 3 weeks for most of the participants, and the dressings were performed twice a week for more than three-quarters of them. As stated before, the BMT has been performed more for patients with multiple myeloma, this may be related to the fact that the multiple myeloma had fewer complications than another medical diagnosis, this result is supported by Rajkumar, (2020) reported that the treatment of newly diagnosed with multiple myeloma is guided by eligibility for Autologous stem cell transplantation and the absence of any risk of graft versus host disease with ASCT.

The age of patients who underwent BMT was between forty to sixty years and from urban, this may be because multiple myeloma which was the medical diagnosis of most is common in people over 40 years old and, the urban people had a better opportunity to have BMT this may result from the rural area having lower access to health care and may have poorer knowledge regarding the procedure.

Furthermore, the type of transplant for more than three-quarters was autologous transplant in the present study because this type of BMT has less complication, the rate of rejection is low, and requires a shorter time than Allogenic. Giralt et al., (2015) found that Autologous transplants have a lower risk of life-threatening complications; there is no risk of Graft versus host disease (GVHD) and no need for immunosuppressive therapy to prevent GVHD and graft rejection.

Hickman line was the most used CVC type; therefore, the internal Jugular vein was the best-inserted vein for the Hickman line. Using a single lumen catheter for most of the participants may be related to simplifying such kind of catheter. An Italy study conducted by Morano et al., (2014) found that the Hickman catheter was the most usually utilized, representing an advance in the management of cancer patients, especially those who require HSCT, in addition, a Japan study explained that the internal jugular vein (IJV) is one of the suggested locations for safe insertion of a central venous catheter, Ishizuka et al., (2010).

In the current study more than two-thirds of patients received 2 bags of Fresenius (hematopoietic stem cell), more than half had a blood transfusion and the majority received platelet. This finding was in line with Akahoshi et al., (2016) who found that the majority of a patient undergoing BMT require platelet transfusion to avoid secondary failure of platelet recovery and almost half needs a blood transfusion.

The current study's result revealed that the incidence of delayed CVC- related complications among patients who underwent BMT was high, the finding indicated that nearly two-thirds of participants complained from CVC-related complications. The incidence of complications was varied; accumulation of the fibrin around the site of catheter insertion was highest which was observed in more than one-third, followed by an infection which was nearly one-third, the occlusion has occurred in less than one-tenth, finally, hematoma around the site of insertion was the least CVC-related complication, Table (4). Regarding the number of complications almost one-third of patients had no complications, more than one-third had only one complication, nearly one-fifths had two, and about four percent had 3 complications together, Figure 2.

The delayed complications of a central venous catheter include infection and device dysfunction. These complications are much more gradual in onset and can occur in the weeks to months after a central line insertion (Kornbau et al, 2015). Patel et al (2019) found that device dysfunction happens when there is a problem with the mechanical components of the central line. A dysfunction of one of them can lead to delayed complications like a fibrin sheath, a catheter fracture, a thrombosis, stenosis, or an infection. The rate of device dysfunction is directly related to the central line site, the duration, and the underlying patient comorbidities.

Barreta et al, (2016) found catheter-associated infections, with a reported incidence varying between 42.5 and 50.6%, another complication was thrombosis after autologous or allogeneic bone marrow transplantation reveals a rate of thrombosis varying from 4.8% to 18.1%.

Furthermore, Khouzam et al, (2013) reported that the development of a fibrin sheath can occur within the first week of central line insertion and can create blockages at the distal openings. This will reduce the ability to draw blood from the line. For treatment, fibrinolytic such as alteplase can be prescribed to dissolve the fibrin sheath, and where fibrinolytic fails, line stripping can be attempted. Hematoma formation has been reported by Vats (2012) in about 4.7% of all central line insertions. Most hematomas formed during central line insertions are benign but some can become sources of infection in patients and lead to abscess formation. Blood can collect in the

thorax or in the mediastinum leading to hemothorax or hem mediastinum, respectively (Patel et al, 2019).

Participants, age, gender, education, and residency had no effect on the occurrence of CVC-related complications. this result is similar to a finding of the study done by Okyere et al., (2021), they clarify that there were no significantly associated between sociodemographic characteristics with the type of CVCs complications,

The incidence of complications as general was higher among leukemic patients; (acute lymphoid leukemia and acute myeloid leukemia) when compared to Hodgkin and Non-Hodgkin lymphoma, and multiple myeloma. On other hand, the complications were observed more in patients who underwent Allogeneic transplantation than Autologous significantly. Our explanation for this finding is may due to receiving high dose immunosuppression chemotherapies as a conditioning regimen, receiving induction of chemotherapy for getting remission before transplant, and the type of transplant for all leukemic patients was Allogeneic transplant in Shahid Shaswary Garmian Hospital. There are two recent studies revealed that leukemic patients who underwent allogeneic transplants are at great risk for CVC-related complications compared to patients with another medical diagnosis. (Beck et al., 2019; Heidenreich et al., 2020).

The CVC-related complications were most common in patients who had Hickman and single lumen, and the internal jugular vein was used for catheter insertion, this may result from that, Hickman lines insertion procedure is more difficult, needs two-incision, and it needs a tunneled site; which increases the risk for complications such as hematoma and infection. This finding is supported by results of a study conducted by Dix et al, (2012) which demonstrated that central venous catheters inserted within the internal jugular or femoral vein had a significantly higher rate of infection compared with those inserted in the subclavian veins.

Furthermore, the patients who had catheters for a long time and who had fewer dressings for catheter insertion sites complained from CVC-related complications more. This finding was expected because increasing the length of stay with catheters and few dressing numbers per weak increase the opportunity for catheter-related infection. This finding was in line with Leistner et al., (2013) results, they found a significantly prolonged stay with catheters in the ICUs associated with CVCs infection.

CONCLUSIONS

The incidence of central venous catheter-related complications was high, almost two-thirds had at least one complication. The most common complications were fibrin and infection. The incidence of complications affects by patients' medical diagnosis, type of transplant and catheter, vein used for insertion of the catheter, the duration of stay with a catheter, and the number of dressings for catheters insertion site. Central Venous Catheter is frequently associated with a number of complications, including device malfunction and/or greater patient morbidity related to longer hospital stays and more expensive medical care. Therefore, handling and monitoring CVC is a very important and responsible aspect of the nurses' work. The complications can be prevented by high-quality nursing care.

ETHICAL CONSIDERATIONS COMPLIANCE WITH ETHICAL GUIDELINES

An administrative agreement was obtained from head of the clinical nursing department, and approved by the College of Nursing, University of Sulaimani, Iraq. The participants were informed about the research's purpose and ensured anonymity and confidentiality of the information. A written informed, voluntary participation consent was obtained from each participant.

FUNDING

This research did not receive any grant from funding agencies in the public, commercial, or non-profit sectors.

AUTHOR'S CONTRIBUTIONS

Study concept; Writing the original draft; Data collection; Data analysis and Reviewing the final edition by all authors.

DISCLOSURE STATEMENT: The authors report no conflict of interest.

ACKNOWLEDGEMENTS

We thank the anonymous referees for their useful suggestions.

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