



Impact of Educational Program on Nurses' Performance Regarding Care of Central Venous Catheter in Hemodialysis Unit

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ABSTRACT

Background: Hemodialysis (HD) is the predominant form of renal replacement therapy (RRT), constituting about 89% of all dialysis treatments. Central venous catheter (CVC) is a necessary component of HD care and they are present in about 43% to 73% of patients. Nurses play a vital role in preventing CVC complications of patients. **The aim:** this study aimed to evaluate the impact of educational program on nurses' performance regarding care of central venous catheter in hemodialysis unit. **The research Design:** A quasi-experimental research design was used to conduct this study. **Setting:** the study was conducted in hemodialysis unit at Fever Hospital, Beni-Suef Governorate. **Sample:** A convenient sample of all available nurses. **Tools:** two tools were used: **Tool I:** interviewing questionnaire to assess demographic data and nurses' knowledge about central venous catheter care. **Tool II:** Observation checklists to assess nurses' practice about central venous catheter care. **The Results:** showed that about all of the studied nurses had satisfactory level of knowledge after program implementation compared to before preprogram implementation 85% of them had satisfactory knowledge level. Also, about the majority of studied nurses after program had competent level of practice compared to implementation more than half of them had incompetent level of practice before program implementation. **Conclusion:** there was statistically significant improvement in nurses' total knowledge level and total practice regarding care of central venous catheter in hemodialysis unit after implementation educational program. **Recommendations:** Further studies are recommended to conduct the training of hemodialysis nurses about the care of central venous catheter.

Keywords: Central venous catheter, Educational program, Hemodialysis, Nurses' performance.

INTRODUCTION

Hemodialysis is the most frequently employed approach for managing advanced chronic kidney failure. Typically conducted three times a week for sessions lasting 3 to 4 hours, this procedure becomes essential when the kidneys can no longer effectively eliminate sufficient waste products and excess fluid from the blood and body (Mohammed & Baez, 2023).

Dialysis refers to the transfer of fluids and molecules across a semipermeable membrane between two compartments. In medical practice, it is a process where substances pass from the blood through a semipermeable membrane into a dialysis solution (dialysate). This procedure helps in managing fluid and electrolyte imbalances and clearing waste products in cases of kidney failure. Additionally, it can be utilized to address drug overdoses. The two primary types of dialysis are peritoneal dialysis (PD) and hemodialysis (HD) (Alsolami & Alobaidi, 2023).

Tunneled, cuffed central venous catheters (CVCs) are widely utilized in the hemodialysis patient population as a long-term alternative to arteriovenous fistulas or arteriovenous grafts (Mohammed & Baez, 2023).

Central venous catheters, often called central lines, play a crucial role in managing adult patients in both critical and non-critical care environments. These devices enable vascular access for delivering fluids, medications, blood products, and parenteral nutrition. However, their use carries risks, including the potential for central line-associated bloodstream infections (CLABSI). CVCs are indwelling devices typically inserted into major central veins, such as the internal jugular, subclavian, or femoral veins. (Weldetensae, et al, 2023).

Nurses hold a vital role in hemodialysis (HD), contributing to preventive, promotive, and curative aspects within the dialysis unit. They ensure an aseptic environment during the insertion process and the preparation of central venous catheter (CVC) insertion kits, as well as

other required equipment, using aseptic techniques. The knowledge, attitude, and practices of HD nurses in managing vascular access (VA) are critical for patient safety, the prevention of complications, efficient use of resources, adherence to best practices for quality improvement, and achieving optimal patient outcomes (Theresa & Mathew, 2022).

Nurses' performance is constantly scrutinized, as their work directly impacts human well-being. They serve as caregivers, providing patient care in various settings such as homes, hospitals, and care centers. Delivering this care requires precision and diligence, as it can have life-or-death consequences. As such, ensuring that nurses perform effectively is essential to guarantee the delivery of high-quality care when needed. However, their performance varies across different regions, influenced by the availability of resources and opportunities for professional development (Mahran, et al., 2024).

It is also crucial to enhance the performance of first-line healthcare workers who are in constant contact with clients, communities, and patients across all healthcare levels. A nurse's performance is influenced by their knowledge, skills, and motivation. Therefore, it is essential to create appropriate working conditions to ensure that nurses can meet the required performance standards and deliver quality care. (Mohammed, et al., 2019).

Significance of the study

The insertion of central venous catheters is one of the most common procedures performed in hemodialysis (HD) units. In Egypt, approximately 54,000 patients are receiving dialysis, with a prevalence rate of 0.65 patients per 1,000 people. In Beni-Suef governorate, the number of HD patients is around 1,300 as of 2023. Catheter-associated bloodstream infections are a significant cause of morbidity and mortality for patients undergoing HD via CVCs. Preventing and monitoring these infections has been identified as a key priority by the United States Department of Health and Human Services (Farag & El-Sayed, 2022) & (Beni Suef Health Directorate, 2023). Insufficient nursing awareness regarding the routine care and maintenance of central venous catheters (CVCs) can result in poor patient

outcomes, including higher complication rates, increased morbidity and mortality, and longer hospital stays. Once the catheter is implanted, it is the nurse’s responsibility to manage its care. Proper care by the nurse plays a crucial role in reducing the development of infections and other catheter-related complications. Educational programs are essential in preventing CVC-related complications and serve as a fundamental tool for raising awareness among healthcare professionals (Xu.F ,et al., 2023).

Aim of the Study:

This study aimed to evaluate the impact of educational program on nurses' performance regarding care of CVC in HD unit through:

- Assess nurses' knowledge regarding care of CVC.
- Evaluate nurses practice regarding care of CVC.
- Evaluate the effect of educational program on nurses' performance regarding care of CVC.

Research hypothesis:

To fulfill the aim of the study, the following research hypotheses are formulated:

H1: Nurses knowledge will be improved after implementation of educational program.

H2: Nurses practice will be improved after implementation of educational program.

Operational definitions:

- Educational program: refers to health education program about CVC care based on CDC guidelines, it is a process of assisting nurses to reach optimum educational development.
- Nurses 'Performance: refers to nurses' knowledge and practice, described as a series of nursing actions or behaviors carried out by nurses, aimed at promoting the recovery and well-being of the patients under their care.
- Central venous catheter: refers to vascular access of HD, a device used to connect the patient with chronic kidney disease to the HD machine.

SUBJECTS AND METHODS

- The present study was carried out through: four designs

I. Technical design.

II. Operational design.

III. Administrative design.

IV. Statistical design.

I. Technical Design

The technical design included (research design, setting, subjects and tools of data collection).

Research design:

A quasi-experimental research design (pre-test /post-test) was utilized to meet the aim of this study.

Setting:

This study was carried out in HD Units (13 rooms with 58 machines) at Fever Hospital, Beni-Suef Governorate.

Subjects:

A convenient sample of available nurses (60 nurses) working in the previously mentioned setting.

Tools of data collection:

This study utilized two data collection tools, which were applied twice: once prior to and again immediately following the implementation of the educational program as follows:

Tool (I): Knowledge Assessment Questionnaire: It was developed by the researcher after reviewing of the current relevant literature reviews based on The Egyptian National Guide to Infection Control& Work guides for the Ministry of Nephrology, (2020). This included the following parts:

Part I: it was concerned with nurses’ demographic data; it includes age, sex, marital status, Qualification, years of experiences and training courses (6 items).

Part II: Nurses knowledge about CVC cares of total (37 items) within three dimensions. It was constructed to assess the nurse’s knowledge as follow:

First Dimension: Information about kidney failure which included: (definition, risk factors, symptoms of kidney failure.....etc (5 items).

Second Dimension: Information about dialysis which included: (complications that occur during the HD session, time required for dialysis, The dry weight for HD patient,...etc.(12items).

Third Dimension: Information on Infection Control which included: (Are standard infection control precautions a way to reduce the incidence of infection from CVC, importance of PPE, hands considered the first factor of infection transmission for the CVC,...etc (20items).

Knowledge scoring system:

It included 17 MCQ questions, each correct answer was given (1 mark), and incorrect was given (zero mark). And 20 True and False, each true answer was given (1 mark), and false was given (zero mark), the total knowledge level considered satisfactory $\geq 75\%$, and unsatisfactory $<75\%$.

Tool (II): Observation checklists: It was developed based on CDC, (2020), and was modified by the researcher to monitor and assess nurses' practice about CVC care. The observation checklist contains total (42 items) within three dimensions as follow:

Hemodialysis catheter connection which included (perform routine hand washing, prepare the equipment, wearing PPE,remove old dressing, remove gloves, Perform antiseptic hand washing,...etc(16 items).

Hemodialysis catheter disconnection which included (perform routine hand washing, prepare the equipment, wearing PEE, perform antiseptic hand washing, wear sterile gloves,...etc(13items).

Hemodialysis catheter exit site care which included (perform routine hand washing, prepare the equipment, wear PEE, remove old dressing, remove gloves,...etc (13items).

Reported practice scoring system: It included 42 steps, each step had three choices to be answered; done correct (2mark), done incorrect (1mark), and not done (zero mark), the total practice level considered adequate reported practice(competent) if $\geq 90\%$, and inadequate reported practice (in competent) if $<90\%$.

II. Operational Design

The operational design included (preparatory phase, pilot study, content validity& reliability and field work).

Preparatory Phase:

The first phase of the study included reviewing related literature and theoretical knowledge of various aspects of the study using books, articles, the internet, periodicals, and magazines to develop tools for data collection. The researcher went through an extensive literature review to prepare the content of the CVC care educational program based on CDC guidelines and a designed colored booklet about(definition, causes, types, symptoms, complications and treating kidney failure, definition and types of dialysis connections, definition, indications and locations for CVC installation, Steps to conduct and interrupt the dialysis session using CVC, Complications of CVC, Symptoms and signs of infection, People most vulnerable to infection, the role of the nurse in nursing care for CVC, Complications that occur during a dialysis session, Health education and nutritional and treatment awareness for dialysis patients).

Pilot Study:

A Pilot study was conducted over a period of three weeks on 10% (6 nurses) under the study to test the applicability, clarity, relevance, feasibility, and efficiency of the developed tools, of included and identify obstacles during data collection, and estimate the time needed for filling the forms. There were no needed modifications for the final developed tools, so the studied nurses who shared in the pilot study were included in the study subjects.

Content Validity:

Established by a panel of five experts (assistant professor of Medical Surgical Nursing department, Faculty of Nursing at Beni- Suef University) who reviewed the tool for clarity, relevance, comprehensiveness, understanding, and its applicability minor

modifications were done and the final form was developed.

Testing reliability:

Reliability coefficients were calculated for the study tools by using Cronbach Alpha (0.843) for knowledge and (0.798) for reported practices.

Field Work:

Prior to conducting the study, official approval was obtained from the Dean of the Faculty of Nursing at Beni Suef University and the Director of Health in Beni Suef. Additionally, permission was granted by the directors of the Fever Hospital. The researcher met with the nurses, explaining the study's objectives. Informed consent was obtained before data collection began. The study was carried out in the hemodialysis units at Fever Hospital, Beni-Suef Governorate, after the purpose of the study was clearly explained.

The pretest was administered by the researcher to the nurses in the study to assess their knowledge and reported practices prior to the program, using tools I and II. Following this, the nurses were divided into four groups, with each group receiving educational sessions on central venous catheter (CVC) care. The educational program was developed based on the results of the pretest. The program plan was then prepared, implemented, and evaluated to assess the improvement in the study group's knowledge. At the conclusion of the eighth session, a post-test was administered to the nurses trained in the program using the same tools (I and II).

The teaching methods employed in the study included modified lectures, brainstorming, demonstrations, re-demonstrations, and group discussions. The researcher utilized various supportive materials, such as real equipment, papers, colored markers, a flip chart, a laptop, colored PowerPoint presentations, and a handout booklet prepared by the researcher.

By the end of each session, the researcher told the nurses about the content and time of the next date of meeting.

Data was collected over six months from (the beginning of December 2023 to the end of May 2024).

Educational program was conducted through three phases:

- Assessment phase.
- Planning & implementation phase.
- Evaluation phase.

1-Assessment Phase:

Pre-intervention included the following:

The study was conducted 3 days per week from 9 am to 2 pm to collect necessary data.

After obtaining permission from the hospital administrator of the previously mentioned settings, the researcher met nurses and introduced herself to each nurse at the start of the interview to explain the aim and nature of the study and obtain their approval and signed consent to participate in the study before any data collection.

The nurses were questioned during this phase to obtain baseline data, to assess the baseline knowledge of the nurses; the researcher was provided them with tool (I) (knowledge assessment questionnaire) to complete (pre-test). To assess the baseline nurse's practices, tool (II) (an observational checklist) was used to watch each one of them while they carried out the actual procedures during connection & disconnection of the patient CVC to dialysis machines and during dressing of CVC.

2-Planning and Implementation phase:

Planning;

The educational program was designed by the researcher according to the nurses' level of comprehension, using simple Arabic language. This was guided by baseline data from the pretest assessment and a thorough review of relevant literature. Various instructional techniques were employed, including modified lectures, brainstorming, demonstrations, re-demonstrations, and group discussions. To ensure the nurses fully grasped the material, appropriate teaching tools were utilized, such as handouts, audio-visual aids, and real equipment.

Implementation: A total of 60 nurses participated in the study, divided into four groups, with 15 nurses in each group. The program was implemented in sessions, with

each group attending 8 sessions. The sessions were divided into four theoretical sessions, each lasting between 30 to 45 minutes, and four practical sessions, each lasting between 45 to 60 minutes. Educational sessions were provided to all participants following CDC and national guidelines for the care and maintenance of central venous catheters (CVCs). The researcher gave each participant a booklet containing all the theoretical and practical information, based on these guidelines. The program lasted between 4 to 8 hours for each group, with ten minutes allocated for discussion and feedback after each session. Each session began with a review of the previous session's lessons and an outline of the goals for the new topics. The training took place over a period of six months.

3-Evaluation phase:

Post-intervention it was including the following;

Following the implementation of the educational program, the post-test was administered to evaluate the nurses' knowledge and practices, using the same tools (I and II) as those used in the pretest.

This was done immediately after the implementation of the educational program. This helped to evaluate the impact of implementing the educational program on nurses' performance regarding the care of CVC in the HD unit.

III. Administrative Design

Official permission was granted by the director of Fever Hospital in Beni-Suef Governorate, based on a letter from the Dean of the Faculty of Nursing at Beni-Suef University. This permission outlined the study's objectives, data collection tools, and the characteristics of the study subjects. The nurses involved in the study were informed about its purpose, written consent was obtained from them, and confidentiality was guaranteed.

Ethical Consideration:

Prior to the pilot study, ethical approval was obtained from the Scientific Research Ethics Committee of the Faculty of Medicine at Beni-Suef University. Official permission was granted by the relevant

authorities at the hospital, and informal consent was obtained from all nurses. The purpose and nature of the study were explained to them before the interview. The researcher emphasized that participation was voluntary, confidentiality was ensured through data coding, and participants had the right to withdraw at any time.

IV. Statistical Design

The collected data were analyzed using the Statistical Package for Social Sciences (SPSS) version 22.0. Descriptive statistics, including frequencies and percentages, were used for categorical variables, while means and standard deviations were calculated for continuous variables. Paired sample t tests were used for analyzing the differences in studied nurses' knowledge and practice through program phases. Pearson correlation coefficient (r) was used for measuring the correlation between numerical variables. Chi square tests (χ^2) were used for correlating categorical variables. Significance level was set at $p < 0.05$.

RESULTS

Table (1) Frequency distribution of studied nurses' demographic characteristics (n=60).

Demographic characteristics	No.	%
Age (years)		
– < 20	4	3.3
– 20 < 30	18	65
– 30 < 40	14	11.7
– 40 < 50	12	10
– ≥ 50	12	10
Mean±SD	31.57±6.65	
Gender		
– Male	5	8.3
– Female	55	91.7
Marital status		
– Single	5	8.3
– Married	52	86.7
– Widow	2	3.3
– Divorced	1	1.7
Nursing Qualifications		
– Diploma in Nursing	17	28.3
– Nursing Technical Institute	11	18.3
– Bachelor of Nursing	28	46.7
– Post graduate	4	6.7
Experience (years)		
– < 1	7	11.7
– 1 < 5	31	51.7
– 5 < 10	8	13.3
– 10 < 15	4	6.7
– ≥ 15	10	16.7
Mean±SD	6.98±3.59	
Training courses on care of CVC		
– Yes	46	76.7
– No	14	23.3

Table (1) showed that, about two thirds (65%) of studied nurses were aged between 20 and 30 years with mean age (31.57±6.65). Concerning their gender and marital status, the majority of studied nurses were female and married (91.7% and 86.7%) respectively. For their education, nearly half of studied nurses (46.7%) had bachelor degree in nursing. More than half of studied nurses (51.7%) had work experience between one and five years with mean experience (6.98±3.59).

Pertaining to nurses’ training, more than three quarters of them (76.7%) had training courses on care of CVC.

Table (2) Mean score of studied nurses’ knowledge regarding care of central venous catheter in hemodialysis unit through program phases (n=60).

Knowledge Dimensions	Range	Pre Program	Post Program	t value	P-Value
		Mean±SD	Mean±SD		
– Knowledge regarding kidney failure	0 – 5	4.75±0.60	5.00±0.00	-3.227	0.002**
– Knowledge regarding hemodialysis	0 – 12	11.01±0.81	11.96±0.18	-9.311	0.000**
– Knowledge regarding infection control	0 – 20	17.31±1.50	19.25±0.65	-9.662	0.000**
Total nurses’ knowledge	0 – 37	33.08±1.99	36.21±0.66	-11.912	0.000**

Table (2) showed that, the total mean score of studied nurses’ knowledge regarding care of CVC in HD unit after program implementation (36.21±0.66) was higher than before program implementation (33.08±1.99). Using paired sample t test revealed that the difference in nurses’ knowledge through program phases were statistically significant ($t=-11.19, P=0.000$).

Table (3) Frequency distribution of studied nurses’ knowledge levels regarding care of central venous catheter in hemodialysis unit through program phases (n=60).

Knowledge Dimensions	Pre Program				Post Program				χ^2	P-value
	Unsatisfactory		Satisfactory		Unsatisfactory		Satisfactory			
	No.	%	No.	%	No.	%	No.	%		
– Knowledge regarding kidney failure	10	16.7	50	83.3	0	0	60	100	10.909	0.001**
– Knowledge regarding hemodialysis	13	21.7	47	78.3	0	0	60	100	14.579	0.000**
– Knowledge regarding infection control	28	46.7	32	53.3	1	1.7	59	98.3	33.149	0.000**
Overall nurses’ knowledge	9	15	51	85	0	0	60	100	9.730	0.002**

Table (3) showed that, after program implementation, all studied nurses (100%) had satisfactory levels of knowledge levels compared to (85%) of nurses who had satisfactory levels before program

implementation. Using chi square test revealed that the difference in knowledge levels through program phases were statistically significant ($\chi^2=9.730, P=0.002$).

Table (4) Mean score of studied nurses’ practice regarding care of central venous catheter in hemodialysis unit through program phases (n=60).

Practice Dimensions	Range	Pre Program	Post Program	T	-value	P
		Mean±SD	Mean±SD			
Catheter Connection	0 – 32	26.45±3.57	30.35±1.03	-9.220	.000**	0
Catheter Disconnection	0 – 26	22.61±2.26	24.75±0.81	-7.627	.000**	0
Catheter Exit Site Care	0 – 26	21.83±3.01	24.60±0.84	-7.969	.000**	0
Total nurses’ practice	0 – 84	70.90±8.34	79.70±2.07	-9.112	.000**	0

Table (4) showed that, the total mean score of studied nurses’ practice regarding care of central venous catheter after program implementation (79.70±2.07) was higher than before program implementation (70.90±8.34). Using paired sample *t* test revealed that the improvement in studied nurses’ practice through program phases were statistically significant ($t=-9.112, P=0.000$).

Table (5) Frequency distribution of studied nurses’ practice levels regarding care of central venous catheter in hemodialysis unit through program phases (n=60).

Practice Dimensions	Pre Program				Post Program				χ^2	P-value
	Incompetent		Competent		Incompetent		Competent			
	No.	%	No.	%	No.	%	No.	%		
Catheter Connection	38	63.3	22	36.7	3	5	57	95	45.384	0.000**
Catheter Disconnection	32	53.3	28	46.7	4	6.7	56	93.3	31.33	0.000**
Catheter Exit Site Care	41	68.3	19	31.7	5	8.3	55	91.7	45.687	0.000**
Overall nurses’ practice	36	60	24	40	3	5	57	95	41.368	0.000**

Table (5) showed that, before program implementation, more than half of studied nurses (60%) had incompetent levels of practice while after program implementation the majority of studied nurses (95%) had competent levels of practice. Using chi square test revealed that the difference in studied nurses’ levels of practice through program phases was statistically significant ($\chi^2=41.368, P=0.000$).

Table (6) Correlation between studied nurses' knowledge and their practice regarding care of central venous catheter in hemodialysis unit (n=60).

Program Phases			Overall Practice
Pre	Overall Knowledge	<i>r</i>	0.419
		<i>P</i> -value	0.000**
Post	Overall Knowledge	<i>r</i>	0.473
		<i>P</i> -value	0.000**

Table (6) showed that, there were statistically significant positive correlation between studied nurses' knowledge and their practice before program implementation ($r=0.419, P=0.000$) and after program implementation ($r=0.473, P=0.000$).

Table (7) Relation between studied nurses' demographic characteristics and their knowledge level at preprogram phase (n=60).

Personal Characteristics	Knowledge Levels Pre Program				χ^2	<i>P</i> -value
	Unsatisfactory		Satisfactory			
	No.	%	No.	%		
Age						
- < 20	0		2	3.3	1.880	0.758
- 20 < 30	7	1.7	32	53.3		
- 30 < 40	0		7	11.7		
- 40 < 50	1	.7	5	8.3		
- ≥ 50	1	.7	5	8.3		
Gender						
- Male	1	.7	4	6.7	0.107	0.744
- Female	8	3.3	47	78.3		
Marital Status						
- Single	0		5	8.3	1.629	0.653
- Married	9	5	43	71.7		
- Widow	0		2	3.3		
- Divorced	0		1	1.7		
Nursing Qualifications						
- Nursing Diploma	2	.3	15	25	0.934	0.817
- Nursing Technical Institute	1	.7	10	16.7		

- Bachelor of Nursing	5	.3	23	38.3		
- Post graduate	1	.7	3	5		
Years of Experience						
- < 1	1	.7	6	10	1.563	0.815
- 1 < 5	5	.3	26	43.3		
- 5 < 10	2	.3	6	10		
- 10 < 15	0		4	6.7		
- ≥ 15	1	.7	9	15		
Training courses on CVC catheter care						
- Yes	7	1.7	9	65	0.007	0.932
- No	2	.3	2	20		

Table 7 showed that, there were non-significant relations between studied nurses' knowledge levels and their demographic characteristics.

Table (8) Relation between studied nurses' demographic characteristics and their practice level at preprogram phase (n=60).

Personal Characteristics	Practice Levels Pre Program				χ^2	P-value
	Incompetent		Competent			
	No.	%	No.	%		
Age						
- < 20	2	3.3	0	0	22.988	0.000**
- 20 < 30	31	51.7	8	13.3		
- 30 < 40	1	1.7	6	10		
- 40 < 50	1	1.7	5	8.3		
- ≥ 50	1	1.7	5	8.3		
Gender						
- Male	4	6.7	1	1.7	0.909	0.340
- Female	32	53.3	23	38.3		
Marital Status						
- Single	4	6.7	1	1.7	4.503	.212
- Married	31	51.7	21	35		
- Widow	0	0	2	3.3		
- Divorced	1	1.7	0	0		
Nursing Qualifications						
- Nursing Diploma	3	5	14	23.3	28.805	0.000**
- Nursing Technical Institute	10	16.7	1	1.7		

- Bachelor of Nursing	23	38.3	5	8.3		
- Post graduate	0	0	4	6.7		
Years of Experience						
- < 1	7	11.7	0	0	32.214	0.000**
- 1 < 5	26	43.3	5	8.3		
- 5 < 10	1	1.7	7	11.7		
- 10 < 15	0	0	4	6.7		
- ≥ 15	2	3.3	8	13.3		
Training courses on CVC catheter care						
- Yes	23	38.3	23	38.3	8.214	0.004**
- No	13	21.7	1	1.7		

Table (8) showed that, there was statistically significant relation between studied nurses' practice levels and their age, educational qualification, experience and training.

Table (9) Relation between studied nurses' demographic characteristics and their practice level at post program phase (n=60).

Personal Characteristics	Practice Levels Post Program				χ^2	P-value
	Incompetent		Competent			
	No.	%	No.	%		
Age						
- < 20	1	1.7	1	1.7	9.528	0.049*
- 20 < 30	2	3.3	37	61.7		
- 30 < 40	0	0	7	11.7		
- 40 < 50	0	0	6	10		
- ≥ 50	0	0	6	10		
Gender						
- Male	1	1.7	4	6.7	2.584	0.108
- Female	2	3.3	53	88.3		
Marital Status						
- Single	0	0	5	8.3	0.486	0.922
- Married	3	5	49	81.7		
- Widow	0	0	2	3.3		
- Divorced	0	0	1	1.7		
Nursing Qualifications						
- Nursing Diploma	0	0	17	28.3	1.763	0.623
- Nursing Technical Institute	1	1.7	10	16.7		
- Bachelor of Nursing	2	3.3	26	43.3		
- Post graduate	0	0	4	6.7		
Years of Experience						
- < 1	0	0	7	1	2.954	0.566

				1.7		
- 1 < 5	3	5	28	46.7		
- 5 < 10	0	0	8	13.3		
- 10 < 15	0	0	4	6.7		
- ≥ 15	0	0	10	16.7		
Training courses on CVC catheter care						
- Yes	1	1.7	45	75	3.315	0.069
- No	2	3.3	12	20		

Table (9) showed that, there were statistically significant relation between studied nurses' practice levels and their age while other variables were not significant.

DISCUSSION

Regarding to demographic characteristics of the studied nurses:

As regards study participants' age, the findings of the present study showed that two-thirds of studied nurses were aged between 20 and 30 years with a mean age (31.57±6.65). This result may be due to the fact that this age of ability to work efficiently and with high production in the work force in the hospital.

This current study result is similar to the previous study finding by Abou Elazayiem Bayumi, et al., (2020), who assessed the "effect of educational program on nurses' performance regarding arteriovenous fistula among hemodialysis patients", data revealed that highly percentage of nurses were in the age group of 25- <30 years with mean age (24.94±4.03). While, this result is contradictory to a study conducted by Hosney, et al., (2021), who assessed "Nurses' Aseptic Technique Knowledge, Practice, and Compliance for Patients Receiving Hemodialysis", finding stated that, more than half of the studied nurses were 20-30 years old.

Concerning gender and marital status, the majority of studied nurses were female and married. From the investigator's point of view, this finding is due to the high percentage of female nurses related to the fact that males were recently engaged in the nursing profession in Egypt. This study result was in agreement with Tahoun, et al., (2022), who examined "Nurses' Knowledge and Practices regarding Tunneled Catheter Care among Patients on Maintenance Hemodialysis", data

reported that the highest percentages of the participants in the study were females and married. Also, this result was in accordance with Singh, et al., (2023), who conducted a study for "assessing the impact of training on healthcare providers' adherence to infection control measures in hemodialysis services", finding that the highest percentages of the participants under the study were married.

As regards to educational level in the current study, the result showed that nearly half of the studied nurses had bachelor's degrees in nursing. In the investigator's opinion, this is due to the importance and necessity of nursing having a higher education or holding a bachelor's degree to work in a dialysis unit.

The existing result was supported by Nagy, et al., (2024), who showed that, more than one-quarter of the studied nurses qualified by a bachelor of nursing. In contrast with Morkes, et al., (2018), who studied the "effect of educational programs on nurses' performance about infection control for patients undergoing hemodialysis", data showed that more than two-thirds of the sample had nursing institute, while a minority of them had bachelor degree in of nursing.

Moreover, the present study result discovered that more than half of the studied nurses had work experience between one and five years with mean experience (6.98±3.59). This result may be due to, the high percentage of nurses were in the age group of 25-<30 years. There's a possibility that there are many nurses in the field during that time period, where the new nurses have gained sufficient

experience but have not yet exceeded five years."

These results were in disagreement with ElsadeqKhadrawi., (2019), who conducted a study titled "Assessment of nurses' knowledge and practice related to caring of central venous line at Al damam Hospital", The results revealed that the studied nurses have 5< 10 years of experience. On the other side, the finding was contrasted with a study performed by Rasheed et al., (2018), who assessed "Nurses' knowledge of the nutritional management of renal failure in Erbil City", data stated that more than half of the respondents 6-10 years'

About nurses' training, more than three-quarters of the studied nurses had attended training courses on the care of central venous catheters. From the investigator's point of view, this finding may be due to most nurses being females with family commitments, which hinder them from attending training programs or workshops, also, they may have a lack of time, a heavy workload, and no availability of training program produced to them from hospital. This means that the hospital is interested in the necessity of providing training courses for nursing in the dialysis unit.

This result disagreed with Elgazar, et al., (2020), who illustrated that less than half of the studied nurses had less than one year to five years and, more than half of them had attended courses toward VA. Furthermore, this result was incongruent with Ismael, (2023), who assessed "Awareness of nurses' knowledge regarding hemodialysis procedure and complications in dialysis center", data discovered that more than half of the studied nurses didn't receive training courses. This difference may be due to hospital regulations that require nurses to take training courses.

This result disagreed with Mahmoud Mahrous, et al., (2024), in a study entitled "Nurses' Knowledge and Practices Regarding Permanent Vascular Access Care among Patients on Hemodialysis" who concluded that the majority of nurses had poor overall nurses' knowledge, and the majority of them had incompetent nurses' practices regarding permanent vascular access care.

As regards to mean score of studied nurses' practice regarding care of CVC in HD unit through program phases, the current study results clarified that the total mean score of studied nurses' practice regarding care of CVC after program implementation (79.70 ± 2.07) was higher than before program implementation (70.90 ± 8.34) and this study results revealed that there was statistically significant improvement in studied nurses' practice through program phases ($P=0.000$).

So, in the light of the current study results, data showed that before program implementation, more than half of the studied nurses had incompetent levels of practice while after program implementation the majority of studied nurses had competent levels of practice. So, there were statistically significant differences in studied nurses' levels of practice through program phases ($P=0.000$).

From the researcher's point of view, this may be due to that nurses who had long years of experience been more competent in caring for HD patients than nurses with fewer years of experience. Also, daily tasks can improve nurses' practices and enrich their experiences.

The current study result was supported by Besely, et al., (2020), who applied a study titled "Effect of Implementing a Health Education Program for Nurses on the Satisfaction Level of patients undergoing hemodialysis" and reported that 70% less than three-quarters of the studied nurses had incompetent total scores of practices pre implementing the educational program. The majority of the studied nurses had competent total scores of practices immediately after implementing the educational program and a month later (follow-up) program implementation respectively.

Correspondingly, this study's results were in accordance with Osman, et al., (2021), who stated that half of the studied nurses had a "poor" level of practice before the application of the educational interventions. While the majority of them had a good level of practice post-intervention. In contrast, this study's results disagreed with Abdo, et al., (2020), who demonstrated that the mean score of studied nurses' practice was (23.72 ± 1.62 to 26.28 ± 1.40 , $p < 0.001$); improvements in the

care and maintenance of central venous catheters (CVCs) were observed among the participants during the post-intervention phase, following the implementation of the educational program.

Regarding Correlations and relations between studies:

Concerning the studied nurses' knowledge and their practice regarding care of CVC in the HD unit, the current study result showed that there was a statistically significant positive correlation between studied nurses' knowledge and their practice before ($P=0.000$) and after program implementation ($P=0.000$). This may be due to that knowledge serves as the foundation for practices.

The existing result was supported by Abou Elazayiem Bayumi, et al., (2020), who showed that there was a highly statistically significant positive relation between total knowledge scores and total practice scores of the studied nurses before and after educational program implementation $r = 0.85$, $r = 0.43$, p -value < 0.000 respectively. Even though, this finding contrasted with Abd Elkhaliq Ibrahim, et al., (2019), who applied a study titled "Assessment of Nurses' Performance regarding the Care of Patients Undergoing Hemodialysis Therapy" and showed that there was no statistically significant relationship between nurses' knowledge and practice in their study ($p > 0.05$).

About studied nurses' demographic characteristics and their knowledge level at the preprogram phase, the current study result showed no statistically significant relations between studied nurses' knowledge levels and their demographic characteristics. The concurrent study result was agreed with Yousef, et al., (2019), who showed that there were no statistically significant relations between studied nurses' knowledge levels except age, and level of education.

Even though the present study's finding disagreed with Besely, et al., (2020), who showed that there was a statistically significant positive correlation between nurses' knowledge scores and their educational qualification, years of experience, and training courses at the pre-program phase ($P < 0.001$).

Concerning studied nurses' socio-demographic characteristics and their practice level at preprogram implementation, the present study result revealed that there was a statistically significant relation between studied nurses' practice levels and their age, educational qualification, experience, and training. From the researcher's point of view, this result may be due to the positive association between advanced age, educational level, and level of experience with increased competent years of practice.

The current study result was in the same line with Abou Elazayiem Bayumi, et al., (2020), who showed that highly statistically significant relationship was found between the total practices of the studied nurses and their educational level and years of experience, both before and after the implementation of the educational program. (p -value < 0.000).

Concerning studied nurses' socio-demographic characteristics and their practice level at post-program implementation, the present study result showed that there was a statistically significant relation between studied nurses' practice levels and their age while other variables were not significant. In my opinion, this may be because, with an increase in age and years of experience, nurses' level of knowledge and practice also will be increased.

The current study results were contradictory with Hussein & Ahmed., (2020), who investigates the Effectiveness of an Educational Program Concerning care of Vascular Access of Hemodialysis; finding revealed that, there is no statistically significant association between the effectiveness of educational programs and demographic data involving age, gender, level of education, occupation, and family number, except the level of education there is significant association with educational program effectiveness at $P \leq 0.05$ level.

In addition, this study's results contrasted with Osman, et al., (2021), who reported that there was a statistically significant relationship between nurses' age, their level of education, and nurse's years of experience after the application of the educational intervention (immediately, one month later).

CONCLUSION

In the light of the current study findings, data concluded that the mean score for nurses' knowledge and practice were higher in the post-educational program than pre-intervention phases which might mean an effective educational program. Also, there was a statistically significant improvement in nurses' total knowledge level and total practice regarding care of CVC in the HD unit after the implementation educational program, there was a positive correlation between total knowledge and total practice through program phases.

RECOMMENDATIONS

- Develop health educational programs and workshops regarding the care of CVC for nurses working in HD units to increase their level of knowledge, awareness, and practices.
- The need to provide developed guides and posters about the care of CVC among nurses in the HD unit.
- Further studies are recommended to conduct the training and teaching of HD nurses about the care of CVC in multiple places.

REFERENCES

- Adane, T., & Getawa, S. (2021). The prevalence and associated factors of hepatitis B and C virus in hemodialysis patients in Africa: A systematic review and meta-analysis. *PLoS one*, 16(6), e0251570. <https://doi.org/10.1371/journal.pone.0251570>
- Alkhaqani, A. L. (2022). Role of physical activity in renal rehabilitation: narrative review. *TMR Non-Drug Ther*, 5(3), 13. <https://doi.org/10.53388/TMRND20220713013>
- Alsolami, E., & Alobaidi, S. (2024). Hemodialysis nurses' knowledge, attitude, and practices in managing vascular access: A cross-sectional study in Saudi Arabia. *Medicine*, 103(13), e37310. DOI: 10.1097/MD.00000000000037310
- Ameh, O. I., Ekrikpo, U. E., Bello, A. K., & Okpechi, I. G. (2023). Complications of Haemodialysis. In *Management of Kidney Diseases* (pp. 363-382). Cham: Springer International Publishing. Available at: https://link.springer.com/chapter/10.1007/978-3-031-09131-5_18
- Arasu, R., Jegatheesan, D., & Sivakumaran, Y. (2022). Overview of hemodialysis access and assessment. *Canadian Family Physician*, 68(8), 577-582. Available at: <https://www.cfp.ca/content/68/8/577.short#:~:text=DOI%3A%20https%3A//doi.org/10.46747/cfp.6808577>
- Bailie, K., Jacques, L., Phillips, A., & Mahon, P. (2021). Exploring perceptions of education for central venous catheter care at home. *Journal of Pediatric Oncology Nursing*, 38(3), 157-165. <https://doi.org/10.1177/1043454221992293>
- Baker, R. J., & Daga, S. K. (2022). Long-Term Management of Kidney Transplant Recipients. In *Primer on Nephrology* (pp. 1663-1687). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-76419-7_95
- Ball, M., & Singh, A. (2024). Care of a Central Line.[Updated 2023 Jul 31]. *StatPearls [Internet]*. Treasure Island (FL): StatPearls Publishing. Available at: <https://pubmed.ncbi.nlm.nih.gov/33232068>
- Beathard, G. A. (2022). Pulmonary embolism associated with dialysis access procedure. *Interventional Nephrology: Principles and Practice*, 195-211. Available at: https://link.springer.com/chapter/10.1007/978-3-030-81155-6_26
- Bogdan, L., & Malavade, T. (2022). Tunneled dialysis line-associated hemorrhagic shock following self-inflicted trauma in a hemodialysis patient: A case report. *Hemodialysis international*, 26(4), E37-E40. <https://doi.org/10.1111/hdi.13035>
- Cawley, C., & Small, M. (2023). Nursing Care of Patients Receiving Home Parenteral Support. In *Intestinal Failure* (pp. 573-618). Cham: Springer International

- Publishing. Available at:
https://link.springer.com/chapter/10.1007/978-3-031-22265-8_37
- Cellini, M., Bergadano, A., Crocoli, A., Badino, C., Carraro, F., Sidro, L., ... & Cesaro, S. (2022).** Guidelines of the Italian Association of Pediatric Hematology and Oncology for the management of the central venous access devices in pediatric patients with onco-hematological disease. *The journal of vascular access*, 23(1), 3-17.
<https://doi.org/10.1177/1129729820969309>
- Cervantes, L., Richardson, S., Raghavan, R., Hou, N., Hasnain-Wynia, R., Wynia, M. K., ... & Tong, A. (2018).** Clinicians' perspectives on providing emergency-only hemodialysis to undocumented immigrants: a qualitative study. *Annals of internal medicine*, 169(2), 78-86.
<https://doi.org/10.7326/M18-0400>
- Chan, K., & Li, X. (2021).** Current Epigenetic Insights in Kidney Development. *Genes*, 12(8), 1281.
<https://doi.org/10.3390/genes12081281>
- Chen, H., Chen, L., Zhang, Y., Shi, M., & Zhang, X. (2022).** Knowledge of vascular access among hemodialysis unit nurses and its influencing factors: a cross-sectional study. *Annals of Palliative Medicine*, 11(11), 3494502-3493502. Available at:
<https://apm.amegroups.org/article/view/104979/html#:~:text=Nov%2010%2C%202022,-.doi%3A%2010.21037/apm%2D22%2D1204>
- Claudel, S. E., Miles, L. A., & Murea, M. (2021, March).** Anticoagulation in hemodialysis: a narrative review. In *Seminars in Dialysis* (Vol. 34, No. 2, pp. 103-115).
<https://doi.org/10.1111/sdi.12932>
- Cobo-Sánchez, J. L., Blanco-Mavillard, I., Mancebo-Salas, N., Moya-Mier, S., González-Menéndez, F., Renedo-González, C., ... & de Pedro-Gómez, J. E. (2023).** Early identification of local infections in central venous catheters for hemodialysis: A systematic review. *Journal of infection and public health*, 16(7), 1023-1032.
<https://doi.org/10.1016/j.jiph.2023.04.012>
- Dabrowiecki, A., Kokabi, N., Hua, H., Palmer, R., & Hawkins, C. M. (2020).** Hospital charges associated with central venous stenosis in pediatric patients requiring long-term central venous access. *The Journal of Pediatrics*, 221, 145-150.
<https://doi.org/10.1016/j.jpeds.2020.03.001>
- Davenport, A. (2023).** Why is intradialytic hypotension the commonest complication of outpatient dialysis treatments?. *Kidney International Reports*, 8(3), 405-418.
<https://doi.org/10.1016/j.ekir.2022.10.031>
- DePietro, D. M., & Trerotola, S. O. (2024).** Central Venous Access. In *IR Playbook: A Comprehensive Introduction to Interventional Radiology* (pp. 125-144). Cham: Springer International Publishing.
https://doi.org/10.1007/978-3-031-52546-9_9
- Dyk, D., Matusiak, A., Cudak, E., Gutysz-Wojnicka, A., & Mędrzycka-Dąbrowska, W. (2021).** Assessment of knowledge on the prevention of central-line-associated bloodstream infections among intensive care nurses in Poland—a prospective multicentre study. *International Journal of Environmental Research and Public Health*, 18(23), 12672.
<https://doi.org/10.3390/ijerph182312672>
- El Khudari, H., Ozen, M., Kowalczyk, B., Bassuner, J., & Almeahmi, A. (2022, February).** Hemodialysis catheters: update on types, outcomes, designs and complications. In *Seminars in interventional radiology* (Vol. 39, No. 01, pp. 090-102). Thieme Medical Publishers, Inc. Available at: <https://www.thieme-connect.com/products/ejournals/abstract/10.1055/s-0042-1742346#:~:text=DOI%3A%2010.1055/s%2D0042%2D1742346>
- Elgazar, W., Raghep, M., Mohamed, H., & Mohamed, R. (2020).** *Effects of an Educational Program on the Nurses' performance regarding Vascular Access Infection Prevention* (Doctoral

- dissertation, Thesis for doctorate degree in nursing science, Medical Surgical Nursing, Faculty of Nursing, Benha University). Available at: <https://fnur.stafpu.bu.edu.eg/Medical%20and%20Surgical%20%20Nursing/5334/publications/wataneya%20kaml.PABER%20WATANYA.pdf>
- Eljaafary, A. E. R., Elsabbagh, M. A., Abdelrahim, M. G., Ahmed, M. F., & Mahmoud, M. I. (2023).** Overview about Complications of Central Venous Catheters of Hemodialysis and Their Prevention in Adults. *The Egyptian Journal of Hospital Medicine*, 91(1), 4554-4559. <https://dx.doi.org/10.21608/ejhm.2023.297776>
- Farag, Y. M., & El-Sayed, E. (2022).** Global dialysis perspective: Egypt. *Kidney360*, 3(7), 1263-1268. Available at: https://journals.lww.com/kidney360/fulltext/2022/07000/global_dialysis_perspective_egypt.19.aspx#:~:text=DOI%3A%2010.34067/KID.0007482021 <https://doi.org/10.34067/KID.0007482021>
- Forneris, G., Marciello, A., Savio, D., & Gallieni, M. (2021).** Ultrasound in central venous access for hemodialysis. *The Journal of Vascular Access*, 22(1_suppl), 97-105. <https://doi.org/10.1177/112972982111019494>
- Furukoshi, M., Tatsumi, E., & Nakayama, Y. (2020).** Application of in-body tissue architecture-induced Biotube vascular grafts for vascular access: proof of concept in a beagle dog model. *The Journal of Vascular Access*, 21(3), 314-321. <https://doi.org/10.1177/1129729819874318>
- Georgeades, C., Rothstein, A. E., Plunk, M. R., & Van Arendonk, K. (2021, December).** Iatrogenic vascular trauma and complications of vascular access in children. In *Seminars in Pediatric Surgery* (Vol. 30, No. 6, p. 151122). WB Saunders. <https://doi.org/10.1016/j.sempedsurg.2021.151122>
- Ghanem, S., & Jamal, Q. (2021).** Nursing Clinical Assessment to Predict Cardiac and Pulmonary Events in the End-Stage Renal Disease (ESRD) (Doctoral dissertation). Available at: <https://repository.najah.edu/server/api/core/bitstreams/788ecc76-1259-4ec0-afc9-b695a528c532/content>
- Gonzalez, T. V., Bookwalter, C. A., Foley, T. A., & Rajiah, P. S. (2023).** Multimodality imaging evaluation of arteriovenous fistulas and grafts: a clinical practice review. *Cardiovascular Diagnosis and Therapy*, 13(1), 196. <https://doi.org/10.21037%2Fcdt-22-439>
- Gorski, L. A., Hadaway, L., Hagle, M. E., Broadhurst, D., Clare, S., Kleidon, T., ... & Alexander, M. (2021).** Infusion therapy standards of practice. *Journal of infusion nursing*, 44(1S), S1-S224. Available at: https://journals.lww.com/journalofinfusionnursing/citation/2021/01001/infusion_therapy_standards_of_practice.8th.1.aspx?context=latestarticles#:~:text=DOI%3A%2010.1097/NAN.0000000000000396
- Hiyamuta, H., Yamada, S., Taniguchi, M., Nakano, T., Tsuruya, K., & Kitazono, T. (2021).** Causes of death in patients undergoing maintenance hemodialysis in Japan: 10-year outcomes of the Q-Cohort Study. *Clinical and Experimental Nephrology*, 25(10), 1121-1130. Available at: <https://link.springer.com/article/10.1007/s10157-021-02089-6>
- Hosney, Z. A., Mohamed, M. A., Abdelmowla, R. A. A., & Azouz, N. (2021).** Nurses' Aseptic Technique Knowledge, Practice, and Compliance for Patients Receiving Hemodialysis. *Assiut Scientific Nursing Journal*, 9(25.0), 145-154. <https://dx.doi.org/10.21608/asnj.2021.80893.1197>
- Hu, K., Li, Y., Ke, Z., Yang, H., Lu, C., Li, Y., ... & Wang, W. (2022).** History, progress and future challenges of artificial blood vessels: A narrative review. *Biomaterials Translational*, 3(1), 81. <https://doi.org/10.12336%2Fbiomatertransl.2022.01.008>

- Hussein, M., & Ahmed, S. (2020). Effectiveness of an educational program on patients' knowledge concerning care of vascular access of hemodialysis in Al-Muthana Teaching Hospitals. *Iraqi National Journal of Nursing Specialties*, 33(1), 33-43. Available at: <https://www.iasj.net/iasj/download/ed745dff8ee9df65>
- Ibrahim, M. E., Zaki, R. S. F., El-Aziz, A., Mohammed, R. S., & AbdElmaksoud, A. E. (2023). Hemodialysis Catheter Infections and The Role of Health Education Program Implementation in Benha University Hospital. *The Egyptian Journal of Hospital Medicine*, 90(2), 3703-3711. <https://dx.doi.org/10.21608/ejhm.2023.293413>
- Ismael, N. H. (2023). Awareness of Nurse's knowledge regarding hemodialysis procedure and complications in dialysis center of Sulaimani City. *Mosul Journal of Nursing*, 11(1), 104-112. <https://doi.org/10.33899/mjn.2023.176963>
- Kar, G., & Kazan, E. E. (2021). Evaluation of skills of intensive care nurses regarding central venous catheter care: An observational study. *Marmara Medical Journal*, 34(3), 298-306. <https://doi.org/10.5472/marumj.1012090>
- Kehagias, E., Galanakis, N., & Tsetis, D. (2023). Central venous catheters: Which, when and how. *The British Journal of Radiology*, 96(1151), 20220894. <https://doi.org/10.1259/bjr.20220894>
- Khudair, H. A., & Khadur, K. M. (2021). Effectiveness of an Educational program on Nurses' Knowledge Regarding Care of Central Venous Catheter in AL-Nasiriyahcardiac center. *Annals of the Romanian Society for Cell Biology*, 25(6), 10036-10042. Available at: <https://www.proquest.com/docview/2616233350?pg-orsite=gscholar&fromopenview=true#:~:text=https%3A/www.proquest.com/scholarly%2Djournals/effectiveness%2Deducational%2Dprogram%2Don%2Dnurses/docview/2616233350/se%2D2>.
- Liakopoulos, V., Roumeliotis, S., Zarogiannis, S., Eleftheriadis, T., & Mertens, P. R. (2019, January). Oxidative stress in hemodialysis: Causative mechanisms, clinical implications, and possible therapeutic interventions. In *Seminars in dialysis* (Vol. 32, No. 1, pp. 58-71). <https://doi.org/10.1111/sdi.12745>
- Lok, C. E., Huber, T. S., Lee, T., Shenoy, S., Yevzlin, A. S., Abreo, K., ... & Foundation, N. K. (2020). KDOQI clinical practice guideline for vascular access: 2019 update. *American Journal of Kidney Diseases*, 75(4), S1-S164. <https://doi.org/10.1053/j.ajkd.2019.12.001>
- Ma, Y., Diao, B., Lv, X., Zhu, J., Liang, W., Liu, L., ... & Wang, H. (2020). 2019 novel coronavirus disease in hemodialysis (HD) patients: Report from one HD center in Wuhan, China. *medrxiv*, 2020-02. Available at: <https://www.medrxiv.org/content/10.1101/2020.02.24.20027201v3#:~:text=doi%3A%20https%3A//doi.org/10.1101/2020.02.24.20027201>
- Mahmoud Mahrous, H., Amin Ahmed, D., & Elsayed Rady, S. (2024). Nurses' Knowledge and Practices Regarding Permanent Vascular Access Care among Patients on Hemodialysis. *Egyptian Journal of Health Care*, 15(2), 1470-1489. <https://dx.doi.org/10.21608/ejhc.2024.371885>
- Mahran, E., Ahmed, A., & Ameen, N. (2024). Nursing Staff's Knowledge and Performance regarding Infection Prevention and Control Measures at the Hemodialysis Unit. *Mansoura Nursing Journal*, 11(1), <https://dx.doi.org/10.21608/mnj.2024.350336>
- Mohammed, A., & Baez, Y. K. (2023). Assessment of Nurses' Knowledge and Practices Regarding Nursing Management for Patients on Hemodialysis at Kirkuk General Hospital/Iraq. *Mosul Journal of Nursing (Print ISSN: 2311-8784 Online ISSN: 2663-0311)*, 11(1), 48-58. <https://doi.org/10.33899/mjn.2023.176945>

- Nagy Azer Azer, A., Said Mahmoud, S., & Fathy Mohamed, R. (2024). Effectiveness of Guidelines on Nurse's Performance Regarding Care of Patient with Non-Tunneled Hemodialysis Catheter. *Journal of Nursing Science Benha University*, 5(1), 645-658. <https://dx.doi.org/10.21608/jnsbu.2024.338675>
- Osman, F. K., El Banna, H. M., Sharaf, A. Y., & Mohammed, Y. F. (2021). The effects of educational interventions on nurses' knowledge and practices in Hemodialysis Unit regarding infection control practices. *The Egyptian Journal of Hospital Medicine*, 84(1), 1739-1748. <https://dx.doi.org/10.21608/ejhm.2021.176470>
- Partovi, S., & Kirksey, L. (2023). Salvaging the thrombosed and stenotic vascular access in the end-stage renal disease population: Lessons learned from recently published studies. *Vasa*. <https://doi.org/10.1024/0301-1526/a001079>
- Pergola, P. E., Devalaraja, M., Fishbane, S., Chonchol, M., Mathur, V. S., Smith, M. T., ... & Davidson, M. H. (2021). Ziltivekimab for treatment of anemia of inflammation in patients on hemodialysis: results from a phase 1/2 multicenter, randomized, double-blind, placebo-controlled trial. *Journal of the American Society of Nephrology*, 32(1), 211-222. Available at: https://journals.lww.com/jasn/fulltext/2021/01000/ziltivekimab_for_treatment_of_anemia_of.21.aspx#:~:text=DOI%3A%2010.1681/ASN.2020050595
- Putra, I. G., Soebroto, H., Yan Efrata Sembiring, Y., Limanto, D. H., Hakim, A. R., Permatananda, P. A., ... & Lim, C. (2023). The longevity of temporary hemodialysis catheters by insertion site in patients undergoing hemodialysis: systematic review. *Italian Journal Of Vascular And Endovascular Surgery*, 30(3). Available at: <https://scholar.unair.ac.id/en/publications/the-longevity-of-temporary-hemodialysis-catheters-by-insertion-site>
- Raina, R., Davenport, A., Warady, B., Vasistha, P., Sethi, S. K., Chakraborty, R., ... & Misra, M. (2022). Dialysis disequilibrium syndrome (DDS) in pediatric patients on dialysis: systematic review and clinical practice recommendations. *Pediatric Nephrology*, 1-12. Available at: <https://link.springer.com/article/10.1007/s00467-021-05242-1>
- Raina, R., Joshi, H., Chakraborty, R., & Sethi, S. K. (2021). Challenges of long-term vascular access in pediatric hemodialysis: recommendations for practitioners. *Hemodialysis International*, 25(1), 3-11. <https://doi.org/10.1111/hdi.12868>
- Rasheed, H. A., Aziz, N. G., Osman, G. A., & Younis, Y. M. (2018). Nurses' knowledge of the nutritional management of renal failure in Erbil City, Kurdistan Region, Iraq. *Zanco Journal of Medical Sciences (Zanco J Med Sci)*, 22(3), 385-393. Available at: <https://www.iasj.net/iasj/download/b0509139de2ea82b>
- Rockholt, M. (2023). Central Venous Catheterization. Aspects of Catheter-Related Infections and Thrombosis. Available at: <https://uicris.lub.lu.se/ws/portalfiles/portal/148690311/Erratablad.pdf>
- Said, N., Lau, W. J., Ho, Y. C., Lim, S. K., Zainol Abidin, M. N., & Ismail, A. F. (2021). A review of commercial developments and recent laboratory research of dialyzers and membranes for hemodialysis application. *Membranes*, 11(10), 767. <https://doi.org/10.3390/membranes11100767>
- Schmiedt, C. W., & Brainard, B. M. (2022). Hemothorax. *Small Animal Surgical Emergencies*, 433-440. <https://doi.org/10.1002/9781119658634.ch37>
- Singh, A. P., Heldaus, J., & Msaki, A. P. (2023). Hemodialysis Complications: A Clinical Insight. *IJARESM*, 11(3), 640-647.

- Available at:
https://www.researchgate.net/profile/Ajit-Singh83/publication/369334337_Hemodialysis_Complications_A_Clinical_Insight/links/64154ed2315dfb4cce8c2d55/Hemodialysis-Complications-A-Clinical-Insight.pdf
- Singh, S., Pandey, H., Aggarwal, H. K., & Pal, S. (2023).** Assessing the Impact of Training on Healthcare Providers' Adherence to Infection Control Measures in Hemodialysis Services. *Cureus, 15*(8). <https://doi.org/10.7759%2Fcureus.42978>
- Smit, J. M., Haaksma, M. E., Lim, E. H., Steenvoorden, T. S., Blans, M. J., Bosch, F. H., ... & Tuinman, P. R. (2020).** Ultrasound to detect central venous catheter placement associated complications: a multicenter diagnostic accuracy study. *Anesthesiology, 132*(4), 781-794. <https://doi.org/10.1097/ALN.00000000000003126>
- Sohail, M. A., Hanane, T., Lane, J., & Vachharajani, T. J. (2021).** Safety of bedside placement of tunneled hemodialysis catheters in the intensive care unit: translating from the COVID-19 experience. *Journal of Clinical Medicine, 10*(24), 5766. <https://doi.org/10.3390/jcm10245766>
- Speer, C., Göth, D., Benning, L., Buylaert, M., Schaier, M., Grenz, J., ... & Klein, K. (2021).** Early humoral responses of hemodialysis patients after COVID-19 vaccination with BNT162b2. *Clinical Journal of the American Society of Nephrology, 16*(7), 1073-1082. Available at: https://journals.lww.com/cjasn/fulltext/2021/07000/early_humoral_responses_of_hemodialysis_patients.14.aspx#:~:text=DOI%3A%2010.2215/CJN.03700321
- Tahoun, A. M., Salem, Y. M., Bedier, N. A., & Ghaleb, M. A. (2022).** Nurses' Knowledge and Practices regarding Tunneled Catheter Care among Patients on Maintenance Hemodialysis. *Alexandria Scientific Nursing Journal, 24*(1), 100-109. <https://dx.doi.org/10.21608/asalexu.2022.246016>
- Tavakoli, N., Momeni, M. K., Sarani, H., Bouya, S., Imani, J. A. R., & Askari, H. (2022).** Effectiveness of Family-Centered Care Education in Care Knowledge of Caregivers of Hemodialysis Patients. *Medical-Surgical Nursing Journal, 11*(1). <https://doi.org/10.5812/msnj-130292>
- Theresa, S. J., & Mathew, R. (2022).** Effect of Simulation-based Learning on Knowledge and Practice Regarding Hemodialysis Catheter Exit Site Care. *Pondicherry Journal of Nursing, 14*(4), 77-79. Available at: <https://doi.org/10.5005/jp-journals-10084-13121>
- Tseng, P. L., Lin, N. N., Hsu, L. P., Tasi, Y. M., Chen, B. C., & Mu, P. F. (2021).** Overcoming barriers to maintain hemodialysis adequacy amongst hemodialysis patients in hospital: a best practice implementation project. *JBIM evidence implementation, 19*(3), 315-326. Available at: https://journals.lww.com/ijebh/abstract/2021/09000/overcoming_barriers_to_maintain_hemodialysis.12.aspx#:~:text=DOI%3A%2010.1097/XEB.0000000000000280
- Türkkan, H., Ayyıldız, T. K., & Sönmez, M. (2022).** Determination of the Knowledge Levels of Nurses Regarding Central Venous Catheter Care. *Journal of Pediatric Emergency and Intensive Care Medicine, 9*(3), 176-183. <https://doi.org/10.4274/cayd.galenos.2021.04909>
- Vachharajani, T. J., Taliercio, J. J., & Anvari, E. (2021).** New devices and technologies for hemodialysis vascular access: a review. *American Journal of Kidney Diseases, 78*(1), 116-124. <https://doi.org/10.1053/j.ajkd.2020.11.027>
- Weldetensae, M. K., Weledegebriel, M. G., Nigusse, A. T., Berhe, E., & Gebrearegay, H. (2023).** Catheter-related blood stream infections and associated factors among hemodialysis patients in a tertiary care hospital. *Infection and Drug Resistance, 3145-3156*. Available at: <https://www.tandfonline.com/doi/full/10.2147/IDR.S409400#:~:text=https%3A%2Fdoi.org/10.2147/IDR.S409400>

Wendel, D., Mezoff, E. A., Raghu, V. K., Kinberg, S., Soden, J., Avitzur, Y., ... & Cole, C. R. (2021). Management of central venous access in children with intestinal failure: a position paper from the NASPGHAN intestinal rehabilitation special interest group. *Journal of pediatric gastroenterology and nutrition*, 72(3), 474-486. Available at: <https://onlinelibrary.wiley.com/journal/15364801>