

Nursing Staff's Knowledge and Performance regarding Infection

Prevention and Control Measures at the Hemodialysis Unit



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1.ABSTRACT

Hemodialysis (HD) patients, as well as dialysis staff, are vulnerable to healthcare-associated infections due frequent and prolonged exposures to multiple possible contaminants in the HD environment. Consequently, infection control is specifically recommended in HD units to reduce the risk of healthcare associated infections (HAIs) and cross contamination of the environment. The current study aimed to assess the nursing staff's knowledge and performance regarding infection prevention and control measures at the hemodialysis unit. **Method:** A cross-sectional study design was utilized to accomplish this study. A Accidental sample of 40 nurses who were involved in providing direct patient care were included in the study at the hemodialysis unit in Dekernes General Hospital. Three tools were used to assess demographic and occupational data, knowledge, and performance of nursing staff. **Results:** The study revealed that 70% of the studied nursing staff had a poor level of knowledge and 67.5% of them had an incompetent performance level regarding infection prevention and control measures at the hemodialysis unit. **Conclusion.** Since the nursing staff had a poor level of knowledge and an incompetent performance level regarding infection prevention and control measures, it is recommended to develop and implement an effective infection control training program for nursing staff to address the gaps in knowledge and performance.

Keywords: Hemodialysis Unit, Infection Control Measures, Nurses' Knowledge and Performance

2.Introduction

characterized by an irreversible deterioration of renal function that gradually progresses to end-stage renal disease (ESRD). CKD has become a disease of public health importance because its prevalence has been increasing both in developing and developed countries with a universal prevalence of 13.4% and a mortality rate of 1.2 million (Yousef et al., 2019). According to the 2010 Global Burden of Disease study, CKD ranked among the top twenty causes of death (Lin et al., 2020).

The Centers for Disease Control and Prevention (CDC) estimated that, more than one to seven (15%) of United States adults (37 million people) are estimated to have chronic kidney disease CKD (CDC, 2019). However The prevalence of CKD was 15.6% in Egypt (Abdelghfar, Elsebae, Elhadry and Hassan, 2017).

Hemodialysis is a therapeutic procedure for patients who have temporarily or permanently lost kidney function due to renal failure (CDC, 2016). The prevalence of patients with end-stage renal

disease (ESRD) on maintenance hemodialysis therapy is growing worldwide. In Egypt, the estimated annual incidence of ESRD is around 74 per million, and the total prevalence of patients on dialysis is 264 per million (Bayoumi, Ahmed, and Hassan, 2019).

Regardless of being a life-sustaining process, HD patients are uniquely vulnerable to the development of healthcare-associated infections (HAIs) because of multiple factors, including exposure to invasive devices, immunosuppression, the lack of physical barriers between patients in the outpatient HD environment, and frequent contact with healthcare workers during procedures and care (Yousef et al., 2019).

Infection is considered the main reason for hospitalization and the second cause of mortality in HD patients. Poor adherence to infection control practices by healthcare personnel (HCP) is the primary reason for the incidence of infection, so consistent and strict adherence to the rules of standard precautions by the HCP is assumed to play a noteworthy role in controlling such infections

(Shokri, Teymourzadeh, Bahadori, Fattahi, and Khodadost, 2019).

Best practice for infection control in dialysis has been described in several evidence-based guidelines. These include guidelines developed by the Center for Disease Control and Prevention (CDC), the Association of Professionals in Infection Control (APIC), and the World Health Organization (WHO). These guidelines address major safety measures such as hand hygiene, the use of personal protective equipment (PPE), injection safety, handling patient's items, cleaning and disinfecting the external surface of dialysis, and the surrounding environment (APIC, 2022; CDC, 2017; WHO, 2020).

The nursing staff is the cornerstone of safely managing HD patients in health care settings. They have a fundamental role in breaking the chain of infection through compliance with infection prevention and control practices. Unfortunately, sometimes nurses utilize optional approaches to infection prevention and control practices (Osman et al., 2021). Therefore, constant training programs must be made by the health care settings to apply evidence based practices to prevent and control infection. These programs must consist of theoretical and practical area to enhance nursing staff's adherence to infection prevention and control practices (Osman, El Banna, Sharaf, and Mohammed, 2021)

Investigating nursing staff's knowledge and performance regarding infection prevention and control measures is necessary to provide effective training. Therefore, the aim of this study is to assess nursing staff's knowledge and performance regarding infection prevention and control measures at hemodialysis unit to identify the gaps that should be addressed by training programs.

Aim of the Study

To assess nursing staff's knowledge and performance regarding infection prevention and control measures at the hemodialysis unit.

3. Method

3.1 Design

A cross-sectional study design was utilized to accomplish this study.

3.2 Setting

The study was carried out at the haemodialysis unit in Dekernes General Hospital affiliated to Misitry of Health and Population, Dakahlia Governorate, Egypt.

This unit is composed of one room for virus-free patients who are on maintenance HD, with a

capacity of 21 dialysis machines. There are other two rooms for isolation of HBV and HCV positive patients with a capacity of 2 and 11 dialysis machines respectively. Another room is available for transmission-based precaution cases, which contain one dialysis machine.

3.3 Participants and sampling:

A convenient sample of all nursing staff (n = 40) who were involved in providing direct patient care throughout the three shifts (morning, evening, and night) at the above-mentioned setting, were included in the study.

3.4 Tools for Data Collection

Data was collected by using three tools that were developed by the researcher based on relevant literature.

Tool (I): Demographic and occupational data self-administered structured questionnaire:

This questionnaire was used to assess the demographic and occupational characteristics of nursing staff, and consisted of two parts:

Part one: This part included demographic data of nursing staff such as: age, gender, qualifications, experience years and previous training courses concerning infection control.

Part two: This part included previous exposure to occupational risk at work, vaccination against HBV, and periodic analysis for infectious diseases. The availability of infection prevention and control guidelines and infection prevention and control equipment in the dialysis unit were also assessed.

Tool (II): Nursing staff's knowledge self-administered structured questionnaire

This questionnaire was used to assess the knowledge of the nursing staff regarding infection prevention and control measures at the hemodialysis unit. It was composed of three categories; (overview of hemodialysis, hemodialysis associated infections, and infection prevention and control measures at the hemodialysis unit). All these categories were composed of 117 questions. One mark was awarded for each correct answer. The total score of knowledge ranged from 0 to 117. According to the researcher's cut of point, the knowledge level was categorized into three categories as follows:

- Poor= scores less than 60% of total scores (less than 70.2 marks).
- Fair= scores 60% to less than 80% of total scores (70.2 - less than 93.6marks).

- Good= scores more than 80% of total scores (93.6 marks and more).

Tool (III): Nursing staff's performance observation checklist.

This checklist was developed based on CDC guidelines (CDC, 2017). It was used to assess nursing staff's performance related to the following domains:-

- a) Hand hygiene.
- b) Personal protective equipment.
- c) Arteriovenous fistula/graft cannulation and decannulation.
- d) Catheter exit site care & hemodialysis catheter connection and disconnection.
- e) Safe injection practices
- f) Hemodialysis station routine disinfection,
- g) Management of blood and body fluid spillages
- h) Respiratory hygiene/cough etiquette.

Each of the above-mentioned domains included sub practices that were scored as the following: "yes= 1 or no= 0". The total score of the nursing staff's performance ranged from 0 to 216. According to the researcher's cut of point, the performance level was categorized into three levels as.

- Incompetent= scores less than 60% of total scores (0 to less than 129.6 marks).
- Improving = scores 60% to less than 85% of total scores (129.6 to less than 183.6 marks).
- Competent = scores 85% and more of total scores (183.6 marks and more).

The validity of the developed tools was tested by the following: the content validity of the developed tool was tested by submitting the tool to a jury of five experts in the field of "community health nursing and infection prevention and control", and the required modification was carried out. Face validity was tested by conducting a pilot study on (10%) of the study sample (4 nursing staff) who had been excluded from the studied sample to evaluate the clarity and applicability of the study tools as well as estimate the approximate time required for data collection. The Cronbach alpha reliability was used to test the reliability of the developed tools. The Cronbach alpha was 0.80 for the knowledge, and 0.94 for the performance. Based on the collected information, the necessary modifications were made.

3.5 Procedure

Ethical considerations: After the approval of the Research Ethics Committee of the Faculty of Nursing, Mansoura University, the official permission for conducting the study was obtained from the Agency of the Egyptian Ministry of Health and the health administration office in Dakahlia Governorate. After clarifying the aim of the study to participants, verbal informed consent was obtained. They assured that their participation in the study was voluntary. Their information and responses were treated anonymously, only used for the purpose of the study and confidentiality was assured through the coding of all data. The results were used as components of the necessary research as well as for further publications and education. Participants were informed that they have the right to withdraw at any time from the study without giving any reason

Literature review: The researcher reviewed national and international literatures regarding infection control in hemodialysis using scientific published articles, internet searches, and textbooks. This review was a guide for developing the study tools

Data collected during the period from July 2021 to the end of October 2021. Before distributing the questionnaire, the researcher started by introducing herself to the nursing staff and explaining the aim of the study. The researcher used data collection tools (I and II) to assess the nursing staff's demographic and occupational characteristics and knowledge regarding infection control in the hemodialysis unit. In addition to, observing the nursing staff's performance throughout hemodialysis sessions by using Tool III. This was carried out three days /week, at the three shifts (morning, evening, and night), and lasted for four months.

Data analysis: Statistical analysis was done according to the most currently reliable and valid statistical methods. The collected data were coded, entered and analyzed using Statistical Package for Social Sciences (SPSS) software version 23 (Armonk, NY: IBM Corp). Descriptive statistics are used to analyze the response to individual items and the respondents' characteristics. Continuous variables were presented as mean \pm SD (standard deviation) and percentages for categorical variable.

4. Results

Table 1 shows that 57.5% of the studied nursing staff were \geq 30 years with a mean age of 31.52 (4.27) years. 92.5 % of them are female and 87.5 % had a bachelor's degree. It was also noticed

that 67.5% of them didn't attend any training programs on infection prevention and control in hemodialysis. As regards previous exposure to occupational risk at work, 75% of the studied nursing staff were exposed to a needle stick. Concerning HBV vaccination, 87.5% of them had been vaccinated. It was also observed that all of them had aperiodic analysis for infectious diseases (virology test).

Figure 1 shows that 37.5% and 45.0% of the studied nursing staff had less than 5 years of experience in the nursing field and in dialysis with a mean of 8.45 (3.99) and 6.65(3.87) years, respectively.

Table 2 reveals that 50.0% of nursing staff reported the absence of infection control guidelines in the dialysis unit. Regarding the availability of infection prevention and control equipment, it was noticed that all nursing staff 100 % reported an adequate supply of infection control equipments including gloves, masks, environmental disinfectants, skin antiseptics, gowns 97.5%, and biohazard containers 95.0%. While only 37.5% of them reported an adequate supply of goggles.

Table 3 clarifies that 75.5% and 92.5% of the nursing staff had a poor level of knowledge

regarding overview about hemodialysis and hemodialysis-associated infections with a mean of 7.25(2.06) and 12.45(4.01) marks, respectively. While 50% of them had a fair level of knowledge regarding infection prevention and control measures at the hemodialysis unit with a mean of 45.05 (8.64). In relation to the total score level of knowledge, 70% of them showed a poor score level of knowledge with a mean of 60.87(10.59) marks.

Table 4 elicits that 52.5%, 52.5%, 80%, 82.5%, 55%, and 70% of the studied nurses had an incompetent performance level regarding hand hygiene, the technique of personal protective equipment, the technique of arteriovenous fistula/graft cannulation and decannulation, the technique of catheter exits site care, hemodialysis catheter connection and disconnection, safe injection practices, and management of blood/body fluid spillages with a mean score of 19.70 (4.80), 31.67 (5.31), 13.70 (3.31), 20.75 (5.22), 8.77 (2.43) and 8.52 (1.96), respectively. While 60% and 65% of the studied nurses had an improving performance level regarding hemodialysis station routine disinfection, and respiratory hygiene/cough etiquette with a mean score of 17.25 (3.27) and 4.37 (0.97), respectively

Table 1 Nursing Staff's Demographic & Occupational Characteristics(n=40)

Item	N=40	%
Age		
Less than 25	4	10
25 to less than 30 years	13	32.5
30 and more	23	57.5
Mean (SD)	31.52 (4.27)	
Gender		
Male	3	7.5
Female	37	92.5
Qualifications		
Master of Nursing	5	12.5
Bachelor of Nursing	35	87.5
Number of the attended training programs on infection prevention and control in hemodialysis		
Non	27	67.5
1-5	4	10.0
6-10	9	22.5
Previous exposure to occupational risk at work *		
Exposure to a splash of blood or body fluids	25	26.5
Needle stick	30	75.0
Vaccinated against HBV	35	87.5
Periodic analysis for infectious diseases (virology test)	40	100.0

The total number may be more than 40 as more than one answer was allowed

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Table 2 The Availability of Infection Control Guidelines and Equipment in The Dialysis Unit(n=40)

Item	N=40	%
Availability of infection prevention and control guidelines in the dialysis unit	20	50.0
Availability of infection prevention and control equipment in the dialysis unit		
Goggles	15	37.5
Biohazard containers	38	95.0
Gown	39	97.5
Gloves	40	100.0
Mask	40	100.0
Environmental disinfectants	40	100.0
Skin antiseptics	40	100.0

Table 3 Nursing Staff's knowledge level Regarding Infection Prevention and Control Measures at The Hemodialysis Unit (n=40)

Item	Poor		Fair		Good		Mean (SD)
	N	%	N	%	N	%	
Overview of hemodialysis (13 marks)	23	75.5	15	37.5	2	5.0	7.25(2.06)
Hemodialysis-associated infections (29 marks)	37	92.5	3	7.5	0	0	12.45(4.01)
Infection prevention and control measures at the hemodialysis unit (75 marks)	19	47.5	20	50.0	1	2.5	45.05 (8.64)
Total Knowledge (117 marks)	28	70	12	30	0	0	60.87(10.59)

Note. **Good**= 80% or more of the total score. **Fair**= scores 80% to less than 60% of total scores. **Poor**= scores less than 60% of the total score

Table 4 Nursing Staff's Total Performance Score Level Regarding Infection Prevention And Control Measures at The Hemodialysis Unit (n=40)

Performance items	Incompetent		Improving		Competent		Mean (SD)
	N	%	N	%	N	%	
Hand hygiene (32 marks)	21	52.5	18	45.0	1	2.5	19.70 (4.80)
Personal protective equipment (52 marks)	21	52.5	19	47.5	0	0	31.67 (5.31)
Arteriovenous fistula/ graft cannulation and decannulation (27 marks)	32	80.0	8	20.0	0	0	13.70 (3.31)
Catheter exits site care, Hemodialysis catheter connection, and disconnection (41 marks)	33	82.5	6	15.0	1	2.5	20.75 (5.22)
Safe injection practices (14 marks)	22	55.0	10	25.0	8	20.0	8.77 (2.43)
Hemodialysis station routine disinfection (28 marks)	16	40.0	24	60.0	0	0	17.25 (3.27)
Management of blood/body fluid spillages (16 marks)	28	70.0	12	30.0	0	0	8.52 (1.96)
Respiratory hygiene/cough etiquette (6 marks)	8	20.0	26	65.0	6	15.0	4.37 (0.97)
Total performance (216 marks)	27	67.5%	13	32.5	0	0	124.75(14.45)

Note. **Incompetent** less than 60, **Improving** 60% to less than 85% **Competent** 85% and more

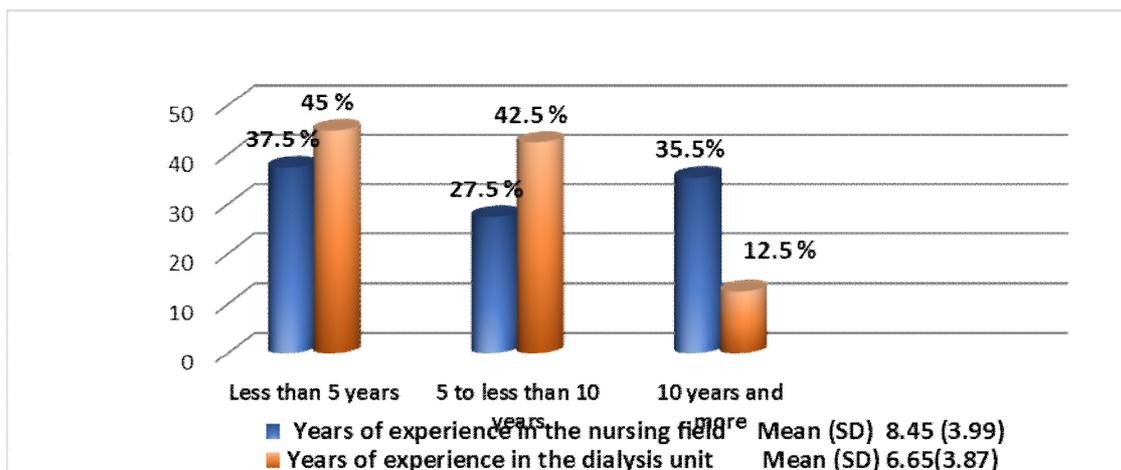


Figure 1: Nursing Staff's Total years of experience in the nursing field and in the dialysis unit

5. Discussion

The main criteria of quality are to achieve adherence in all the procedures and processes, which include care for patients, compliance with treatment protocols, documentation, and staff approach **Alhumaid et al., (2021)**. An effective Infection Prevention and Control (IPC) program is fundamental to quality health care. This is because it has the potential benefits of reducing the burden of disease on

patients, health institutions and the nation as a whole **Ziblim, Suara, and Tahiru (2020)**.

Prevention of infection is within the nursing staff's scope of practice. Healthcare workers and nursing staff in particular are constantly exposed to microorganisms while performing different procedures. Therefore, they should have sound knowledge and strict adherence to infection control guidelines **Yassin et al., (2018)**.

The current study indicates that, the majority of the studied nursing staff had poor score level of knowledge regarding hemodialysis. This result is in the same line with a study conducted by **Abdel-latif et al. (2019)** illustrated that; more than half of the studied nurses had incorrect knowledge concerning hemodialysis. Along the same line, a study conducted by **Ismael, (2023)** revealed that the level of knowledge about hemodialysis was considerably low among the nurses.

As regards hemodialysis associated infections the current study indicates that, most of the studied nursing staff had a poor score level of knowledge regarding infections associated with hemodialysis. This finding is inconsistent with a study carried out by **Bny Uoda, (2019)**, which found that, the knowledge level regarding infectious diseases and how they occur among nurses was good.

Based on the results of the present study, the majority of the studied nursing staff had a poor score level of knowledge regarding infection prevention and control measures at the hemodialysis unit. The researcher interprets the results belonged to nursing staff's knowledge in light of the fact that more than half of them didn't receive training, which sheds light on the importance of pre- and in-service training program. In addition to the absence of written policies and guidelines for infection control precautions as our findings illustrated.

This finding is consistent with other two studies carried out recently in Egypt: the first one by **Osman, El Banna, Sharaf, and Mohammed, (2021)**, who conducted an interventional study to improve nurses' knowledge and practices in hemodialysis units regarding infection control practices and reported that nearly two thirds of the studied nurses had poor overall knowledge before interventions. The second study was conducted by **Yassin et al. (2018)**; they studied knowledge and practices regarding infection control (IC) among hemodialysis nursing staff and reported that IC knowledge of the nursing staff was generally low. The two previous studies emphasized the importance of training programs and recommended the need for continuous educational programs for nursing staff to help them improve their knowledge, which in turn leads to better practice behavior and clinical practice outcomes.

On the other hand, this finding disagrees with an Egyptian study conducted by **Amer et al. (2022)**, in El Mahalla El Kobra, Gharbia Governorate, which declared that; the majority of the studied healthcare providers had good knowledge regarding IC precautions in HD units. As well, a study carried out in Saudi Arabia by

Hamid et al. (2019), showed that more than half of the studied health-care providers, including physicians, nurses, and equipment's maintenance technicians, had good knowledge level regarding IC precautions.

Based on the result of the present study, more than two thirds of the studied nursing staff had an incompetent total performance level regarding infection control measures. From the research's point of view, the findings of the present study may be attributed to several factors, including the nursing staff shortage, work overload in the HD unit, the time constraints of having to connect or disconnect a large number of patients within a limited time, and a lack of knowledge and awareness about infection control measures as a result of a lack of training programs, as our findings illustrated. This result is supported by **Mohamed, El-Sayed, and Alanwer (2021)**; **Morkes et al.(2018)**; **Machaly et al.(2020)** and **Porto and Marziale (2016)**, who revealed that insufficient knowledge, workload and inadequate training are the major causes of noncompliance with infection control measures.

However, this result is inconsistent with **Nofal et al. (2017)** who revealed a higher compliance rate with infection control measures among staff nurses in their studies

The major route of transmission of health-associated infections (HAIs) is through the transiently contaminated hands of health care providers. The present study demonstrates that, more than half of the studied nursing staff had an incompetent performance level regarding hand hygiene. this result may be related to a lack of policy that determine fixed punishment for noncompliance with fixed procedures by all nurses, a lack of motivation, skin irritation due to frequent hand hygiene, urgent patients' needs, work load, nursing staff shortage, as well as lack of continuing education. This finding was consistent with the results of previous studies (**Prathibha et al. (2020)**; **Elsaidy, et al. (2019)**; **Abdelwahab et al. (2019)** and **Karkar (2018)**).

Moreover, a study done on 18 hemodialysis units in Dakhlia governorate, Egypt conducted by **Khamis, et al. (2018)** found that the medical team doesn't carry out proper and enough hand washing.

However, this finding is in disagreement with a study conducted by **Ashinyo et al. (2021)** which found that the majority of respondents had high compliance levels for hand hygiene.

Concerning personal protective equipment (PPE). The present study reveals that more than

half of the studied nursing staff had an incompetent performance level regarding PPE. These findings correspond with the finding of studies conducted by **El-Greeb et al. (2018)**; **Osman et al. (2021)** and **Mohamed, El-Sayed, and Alanwer (2021)** in Egypt. Also **Mukhtad et al. (2019)** in Benghazi which found that nurses' use of PPE was "unsatisfactory". They postulated that perhaps nurses assumed that the priority in emergency situations is not donning PPE, but rather providing rapid patient care. They assumed that work load probably does not give nurses time to use PPE, nurses may feel discomfort with PPE, large number of HD patients and the many procedures needed in one session, as well as lack of up- to date training on the principles of standard precautions all of which add to the problem.

However, these results are congruent to **Refeai et al. (2020)** who conducted study in Minia University Hospital and revealed that the most commonly reason for noncompliance was non availability of PPE.

Regarding safe injection practices the result shows that, more than half of the studied nursing staff had an incompetent performance level regarding safe injection practices. This result is similar to a study carried out by **Tabash et al. (2018)** and **Yassin et al., (2018)** who reported low nurses' compliance with safe injection practices and sharps handling.

Hospital acquired infection transmitted by contaminated environmental surfaces with different pathogens on surfaces. The disinfection of dialysis machine between patient uses is recommended at the beginning and/or end of the day **Nguyen, Arduino, & Patel, (2019)**. At the present study two third of the studied nursing staff had improving performance level regarding hemodialysis station routine disinfection. This finding is in agreement with **Bayoumi, Ahmed, & Hassan, (2019)** who mentioned that nurses' compliance to clean and disinfect dialysis station and disinfect the dialysis machine was satisfactory.

In relation to arteriovenous fistula/ graft cannulation and decannulation, catheter connection and disconnection, and catheter exit site care. The present study demonstrates an incompetent performance level among the majority of the studied nursing staff. This finding is in agreement with **Mohamed et al. (2019)**; **El Daly B., Mohamed S., and Omran E., (2022)** and **Parisotto et al. (2017)** who mentioned that nurses had poor performance level regarding vascular access care provided to hemodialysis patients.

According to the retrieved field notes throughout the data collection of the present study shortage of nursing staff, work overload, inadequate infection control policies, as well as insufficient training of the nursing staff. All of these factors lead to the observed poor knowledge and incompetent performance level among the studied group.

6. Conclusion

Based on the findings of the present study, it can be concluded that the majority of the studied nursing staff had poor level of knowledge and more than two thirds of them had an incompetent performance level regarding infection prevention and control measures at the hemodialysis unit

Based on the findings and conclusions drawn from the study, the following recommendations are suggested:

- Provide in-service training programs for all nurses to keep them up-to-date on data regarding infection control measures.
- Provision of standards and procedure manuals on infection prevention and control measure at HD units is mandatory
- Establish follow up system at the dialysis unit to ensure application of all infection prevention and control measures

7. Acknowledgments

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8. References:

- Abdelghfar, S. Z., Elsebae, H. A., Elhadry, S. M., & Hassan, A. A. (2017). Effect of Aromatherapy on Uremic Pruritus among Patients Undergoing Hemodialysis. *IOSR J Nurs and Heal Sci*, 6(2), 22-30.
- Abdelwahab, M. A., Labah, E. A. R., Sayed, L. M., Elbedwey, M. M., & Gabr, H. M. (2019). Impact of Infection Prevention and Control Education Program on Improving Knowledge, Attitude and Practices of the Healthcare Staff in Hemodialysis Unit at Egyptian Tertiary Care Facility. *Asian Journal of Medicine and Health*, April 2019, 1–11. <https://doi.org/10.9734/ajmah/2019/v14i430109>.
- Abdel-latif, N. A., Elghany, O. A., Abdel-aziz, M. A., & Elhamid, S. K. A. (2019). Assessment of Nurses Knowledge and Practices Regarding Complications of Hemodialysis Patients in Intensive Care Unit Tools : December, 9–17.

- Alhumaid, S., Al Mutair, A., Al Alawi, Z., Alsuliman, M., Ahmed, G. Y., Rabaan, A. A., . . . Al-Omari, A. (2021). Knowledge of infection prevention and control among healthcare workers and Factors Influencing Compliance: A systematic review. *Antimicrobial Resistance & Infection Control*, 10(1). doi:10.1186/s13756-021-00957-0
- Al Qahtani, A. S., & Almetrek, M. A. (2017). Knowledge, Attitudes and Practice of Nurses in Renal Dialysis Units regarding Infection Control in Abha City, Saudi Arabia, 2015. *The Egyptian Journal of Hospital Medicine*, 66, 103–114. <https://doi.org/10.12816/0034640>
- Amer, R., Ali, G., Atalla, A., & Saied, S. (2022). Application of infection-control guidelines in hemodialysis units in El Mahalla El Kobra, Gharbia Governorate. *Tanta Medical Journal*, 50(3), 189. https://doi.org/10.4103/tmj.tmj_50_20
- Ashinyo, M. E., Dubik, S. D., Duti, V., Amegah, K. E., Ashinyo, A., Asare, B. A., Ackon, A. A., Akoriyea, S. K., & Kuma Aboagye, P. (2021). Infection prevention and control compliance among exposed healthcare workers in COVID-19 treatment centers in Ghana: A descriptive cross-sectional study. *PloS one*, 16(3), e0248282- e0248282. <https://doi.org/10.1371/journal.pone.0248282>
- Association for Professionals in Infection Control and Epidemiology (APIC). (2022). *Infection Prevention and Control in Dialysis Settings About the Implementation Guide Series*. https://apic.org/wp-content/uploads/2022/04/Dialysis_ImplementationGuide3.pdf
- Bayoumi, M. H., & Mahmoud, N. F. (2017). Effect of education program on nurses' knowledge and practice regarding care of central venous line in pediatric hemodialysis: evidence-based practice guidelines. *Egyptian Nursing Journal*, 14(2), 87.
- Bayoumi, M., Ahmed, A., & Hassan, H. (2019). Nurses' practices toward applying infection control measures using notice checklists at a Dialysis Unit. *Connect: The World of Critical Care Nursing*, 13(2), 90-101. https://doi:10.1891/1748_6254.13.2.90
- Bny Uoda, A. (2019). Knowledge, attitudes and practices for dialysis nursing staff regarding personal protection means from hospital

- acquired in MOUSL Hospital. *Mosul Journal of Nursing*, 7(2), 91-99. doi:10.33899/mjn.2019.163661
- Center for Disease Control and Prevention (CDC). (2020). *Clinician Education | Dialysis Safety | CDC*. <https://www.cdc.gov/dialysis/clinician/index.html>
- Center for Disease Control and Prevention (CDC). (2017). *Dialysis Safety, Guidelines, Recommendations and Resources*. <https://www.cdc.gov/dialysis/guidelines/index.html>
- Centers for Disease Control and Prevention (2016). Water Use in Hemodialysis. Retrieved from <https://www.cdc.gov/dialysis/guidelines/water-use>
- Centers for Disease Control and Prevention (2017). Audit Tools and Checklists. Retrieved from <https://www.cdc.gov/dialysis/prevention-tools/audit-tools.html>.
- Centers for Disease Control and Prevention (2019). Chronic Kidney Disease in the United States. Atlanta, GA: US Department of Health and Human Services. Retrieved from <https://www.cdc.gov/kidneydisease/publications-resources/2019-national-facts.html>.
- Chan, C. T., Blankestijn, P. J., Dember, L. M., Gallieni, M., Harris, D. C. H., Lok, C. E., Mehrotra, R., Stevens, P. E., Wang, A. Y. M., Cheung, M., Wheeler, D. C., Winkelmayer, W. C., Pollock, C. A., Abu-Alfa, A. K., Bargman, J. M., Bleyer, A. J., Brown, E. A., Davenport, A., Davies, S. J., Zakharova, E. (2019). Dialysis initiation, modality choice, access, and prescription: conclusions from a Kidney Disease.
- Duong, M. C., & McLaws, M. L. (2017). Dangerous practices in a hemodialysis unit in Vietnam identify from mixed methods. *BMC infectious diseases*, 17(1), 181.
- El-Greeb H, Amel I, Hussien M et al. (2018). Assessment of nurses' compliance with infection control standard precautions at outpatient clinics of Urology and Nephrology Center–Mansur University. *Journal of Nursing and Health Sciences*, 7(3): 54-59.
- Elsaidy Z, Weheida S, Zaki S et al. (2019): Risk factors exposing hemodialysis patients to blood borne infections. (Master thesis): Faculty of Nursing. http://main.eulc.edu.eg/eulc_v5/Libraries/Thesis/BrowseThesisPages.aspx?fn=PublicDrawThesis&BibID=12626034
- Farotimi, A. A., Ajao, E. O., Ademuyiwa, I. Y., & Nwozichi, C. U. (2018). Effectiveness of training program on attitude and practice of infection control measures among nurses in two teaching hospitals in Ogun State, Nigeria. *Journal of education and health promotion*, 7.
- Gowda, R. S., & Suma, V. (2017, February). A comparative analysis of traditional education system vs. e-Learning. In *2017 International Conference on Innovative Mechanisms for Industry Applications (ICIMIA)* (pp. 567-571). IEEE.
- Hamid, H. A., Mustafa, M. M., Al-Rasheedi, M., Balkhi, B., Suliman, N., Alshaafee, W., & Mohammed, S. A. (2019). Assessment of Hospital Staff Knowledge, Attitudes and Practices (KAPS) on Activities Related to Prevention and Control of Hospital Acquired Infections. *International Journal of Prevention and Treatment*, 8(1), 1–7. <https://doi.org/10.5923/j.ijpt.20190801.01>
- Hayes, B., Bonner, A., & Douglas, C. (2015). Haemodialysis work environment contributors to job satisfaction and stress: A sequential mixed methods study. In *BMC Nursing*(Vol.14,Issue).<https://doi.org/10.1186/s12912-015-0110-x>
- Ibrahim El Daly, B., Said Mohamed, S., & Sobhy Omran, E. (2022). Assessment of nurses performance regarding arteriovenous fistula cannulation and suggested guidelines for prevention of its failure. *Journal of Nursing Science Benha University*, 3(2), 15-25. doi:10.21608/jnsbu.2022.244317
- Ismael, N. (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. doi:10.33899/mjn.2023.176963
- Jabbar, H. M., & Mohammed, W. K. (2021). Effectiveness of Education Program on Nursing Staff Knowledge toward Infection Control Measures at Hemodialysis Unit in Al-Dewaniya Teaching Hospital. *Annals of the Romanian Society for Cell Biology*, 25(6), 11696-11702.

- Karkar A (2016): Hand hygiene in haemodialysis units. *Open Access Library Journal*, 3(08): 1-5.
- Karkar, A. (2018). Infection control guidelines in hemodialysis facilities. *Kidney Research and Clinical Practice*, 37(1), 1–3. <https://doi.org/10.23876/j.krcp.2018.37.1.1>
- Khamis, S. S., Yasin, Y. S., Omara, M. M., & Saleh, N. E. (2018). Safety measures in Dakhliya hemodialysis units. *Menoufia Medical Journal*, 31(2), 429.
- Krans, B., & Gotter, A. (2018). Dialysis: Purpose, Types, Risks, and More. In *Healthline*. <https://www.healthline.com/health/dialysis#outlook>
- Krishnan, N. (2021). A hemodialysis curriculum for nephrology fellows using a blended learning approach: best of both worlds? *Journal of Nephrology*, 34(5), 1697–1700. <https://doi.org/10.1007/s40620-020-00945-4>
- Lally, R. M., Eisenhauer, C., Buckland, S., & Kupzyk, K. (2018, November). Feasibility of synchronous online focus groups of rural breast cancer survivors on web-based distress self-management. In *Oncology nursing forum* (Vol. 45, No. 6, p. E111). NIH Public Access.
- Lin, Q., Mao, L., Shao, L., Zhu, L., Han, Q., Zhu, H., . . . You, L. (2020). Global, regional, and national burden of chronic myeloid leukemia, 1990–2017: A systematic analysis for the global burden of disease study 2017. *Frontiers in Oncology*, 10. <https://doi:10.3389/fonc.2020.580759>
- Lok, C. E., Huber, T. S., Lee, T., Shenoy, S., Yevzlin, A. S., Abreo, K., Allon, M., Asif, A., Astor, B. C., Glickman, M. H., Graham, J., Moist, L. M., Rajan, D. K., Roberts, C., Vachharajani, T. J., & Valentini, R. P. (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>
- Machaly E, Bahgat R, Hassan H et al. (2020). Effect of implementing evidence based nursing guidelines on nurses' performance about care provided for children undergoing hemodialysis. *Journal of Nursing and Health Sciences*, 9(3): 21-28.
- Med M, Pedro Pallangyo M, Med M (2020): Adherence to universal precautions and associated factors among nurses caring for critically ill patients in Dar es Salaam Tanzania. *Journal of Nursing and Health Care*, 3(3): 106-113.
- Mohamed, R., El-Sayed, N., & Alanwer, H. (2021). Nurses' compliance with infection control standard precautions in dialysis units. *Alexandria Scientific Nursing Journal*, 23(1), 116-126. doi:10.21608/asalexu.2021.206065
- Mohamed, M., Abuaisha, H., and Khojaly, M. (2019). Nursing Competency with Vascular Access Care among Hemodialysis Patients in Arab World: A Narrative Review, *Journal of Nursing*; 2(12): 25.
- Morkes, S. M., Abozead, S. E. S., & Azer, S. Z. (2018). Effect of Educational Program on Nurses performance About Infection Control for Patients Undergoing Hemodialysis. *Assiut Scientific Nursing Journal*, 6(15), 162-168.
- Moursy A, Sharaf A (2017): Vascular access care at hemodialysis unit; nurses compliance to infection prevention and control practices. *IORS Journal of Nursing and Health Science*, 6(2): 6-10.
- Mukhtad A, Alfahkry R, Mousa W et al. (2019). Assessment of Knowledge, Attitudes and Practices of Nurses Regard Infection Control Program in El-Hawwary Renal Dialysis Centre in Benghazi City, Libya. *International Journal of Advances in Nephrology Research*, 19: 1-10.
- Nguyen, D. B., Arduino, M. J., & Patel, P. R. (2019). Hemodialysis-associated infections. *Chronic Kidney Disease, Dialysis, and Transplantation*, 389
- Nofal M, Subih M, Al-Kalalkeh M et al. (2017): Factors influencing compliance to the infection control precautions among nurses and physicians in Jordan: A cross-sectional study. *Journal of Infection Prevention*, 18(4): 182-188.
- 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. *Egyptian Journal of Hospital Medicine*, 84(1), 1739–1748. <https://doi.org/10.21608/EJHM.2021.176470>
- Porto, J. S., & Marziale, M. H. (2016). Reasons and consequences of low adherence to standard precautions by the nursing team. *Revista gaucha de enfermagem*, 37(2),

- e57395. <https://doi.org/10.1590/1983-1447.2016.02.57395>.
- Prathibha J, Lobo D, Nayak S et al. (2020). Practice and perceived barriers among health care workers to control infection in dialysis unit. *Medico Legal Update*, 20(1): 165- 169
- Queeley, G. L., Campbell, E. S., & Ali, A. A. (2018). Assessing the level of patient-specific treatment recommendations in clinical practice guidelines for hemodialysis vascular access in the United States. *American health & drug benefits*, 11(5), 223.
- Rajkhowa, R. (2019). Care for Hemodialysis Patients ; Barriers and Facilitators in Selected Hospitals in Ranchi. 1, 43–44.
- Refeai S, Kamal N, Ghazawy E et al. (2020): Perception and barriers regarding infection control measures among healthcare workers in Minia city, Egypt. *International Journal of Preventive Medicine*, 11:1-6.
- Saggu, Y., Asmat, K., Margrate, M., & Ahmad, N. (2018). Preventing Central Line Infections among Hemodialysis Patients: Nurses' Knowledge and Practices in Accordance with Center for Disease Control and Prevention (CDC) Guidelines. *Israel Medical Journal*, 10(2), 102-108.
- Shokri, A., Teymourzadeh, E., Bahadori, M., Fattahi, H., & Khodadost, M. (2019). Nurses' competency and their role in prevention and control of hospital infections: A case study in a large military teaching hospital. *Advances in Human Biology*, 9(2), 156. https://doi:10.4103/aihb.aihb_1_19
- Suprpto S (2020): Nurse compliance using basic personal protective equipment in providing health services nursing actions. *International Journal of Medicine and Public Health*, 10(3): 119-121.
- Tabash, M., Kashkash, R. & Eljedi, A. (2018). Compliance of health-care staff toward infection control precautions in hemodialysis units–Gaza governorates. *Innovare Journal of Health Sciences*, 6(1), 34-40.
- Vijayan, A. & Boyce, J. (2018). 100% use of infection control procedures in hemodialysis facilities: Call to action. *Clinical Journal of the American Society of Nephrology*, 13(4), 671–673. <https://doi.org/10.2215/CJN.11341017>
- Wong, L. P. (2018). Systems thinking and leadership: How nephrologists can transform dialysis safety to prevent infections. In *Clinical Journal of the American Society of Nephrology* (Vol. 13, Issue 4, pp. 655–662). <https://doi.org/10.2215/CJN.09740917>
- World Health Organization(WHO)(2020). Hand hygiene in outpatient and home-based Care and long-term care facilities. <https://www.nric.org.uk/node/53029>
- Yassin S, Soliman M, Hoda I et al. (2018): Assessment of Infection Control Knowledge and Practices among Hemodialysis Nursing Staff in Kasr Al-Ainy Hospitals. *The Medical Journal of Cairo University*, 86: 1649-1656.
- Yeh, L. M., Chiu, S. Y. H., & Lai, P. C. (2019). The Impact of Vascular Access Types on Hemodialysis Patient Long-term Survival. In *Scientific Reports* (Vol. 9, Issue 1). <https://doi.org/10.1038/s41598-019-47065-z>
- Yousef, Y., Elashir, U., Mahmoud, S., & Maghraby, N. (2019). The effect of nursing educational program on knowledge and practice of nurses regarding infection control measures for children under hemodialysis. *Egyptian Nursing Journal*, 16(1), 1. <https://doi.org/10.4103/2090-6021.257964>