Medical

Assessment of nurses' knowledge working in hemodialysis units toward infection control measures in Al-Najaf city hospitals

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Abstract

Background: Renal failure patients undergoing hemodialysis treatment and nursing staff working in hemodialysis units are at a significantly increased risk of healthcare-acquired infections, for example, blood-borne diseases and bacterial and fungal infections due to repeated and prolonged exposure to many potential pollutants in the hemodialysis setting. Nursing staff's compliance with infection control and prevention measures reduces transmission; therefore, nurses working in hemodialysis units must follow standard precautions.

Objective: The aim of the study is to assess the knowledge of nurses working in hemodialysis units towards infection control measures.

Materials and Method: Quantitative design (the descriptive cross-sectional study) was used to achieve the objectives of this study. This study was conducted in the hemodialysis units at Al-Najaf city hospitals in Iraq between March 2022 and April 2022 based on a non-probability sampling (purposive sampling); the sample consisted of hundred nurses. A questionnaire was prepared as a data collection tool and consists of two parts. The first part includes the socio-demographic information of the nursing staff, and the second part contains 39 multiple-choice questions aiming to assess nurses' knowledge working in hemodialysis units about infection control measures. Descriptive and inferential statistics were used to analyze the study results using the statistical package of Social Sciences (SPSS) version 20 and Microsoft Word and Excel (2010).

Results: The study results revealed that the nurses' knowledge of the infection control measures was moderate (74,95%) and had a statistical mean score of 1,499. The findings also showed a high level of statistically significant correlation between nurses' knowledge of working in hemodialysis units and socio-demographic information in line with the critical and unique nature of hemodialysis units, such as the educational level of socio-demographic information, participation in training courses on hemodialysis units inside and outside Iraq, and participation in training courses on infection control measures training inside and outside Iraq, the number of infection control training courses, and duration of infection control training courses. The probability value was ($p <= 0,05$).

Conclusions: The study concluded that most participants had knowledge about infection control measures. A highly statistically significant correlation existed between nurses' knowledge levels and socio-demographic information. Still, because of the critical and unique nature of hemodialysis units, very strict procedures must be imposed, and nursing staff must be trained on infection control measures for hemodialysis units.

Keywords: hemodialysis, infection control measures, knowledge, nurse

Introduction

Infection prevention and control measures constitute the central pillar to preventing the outbreak of infections and reducing the spread of infections in hospitals and healthcare centers as they cause serious harm to patients, healthcare workers, and the community. It is a reliable scientific method and a sound practical decision since it strengthens pathology, epidemiology, and health systems. Infection control occupies a privileged position in the global health system because it concerns the safety of both patients and healthcare personnel, prevents complications of infections, and reduces financial burdens over countries' health systems (Rajih, 2020) [29]. Healthcare-acquired infections detected after admission to hospitals or other healthcare settings, including hemodialysis units, are called nosocomial or healthcare-acquired infections (Jabbar and Mohammed, 2021) [28].

Hemodialysis units are considered highly epidemic areas

where viral, bacterial, fungi, parasites, and other serious diseases are common and affect patients and the medical staff working in those units. In order to prevent these infections, these units must have special areas or establish strict measures to control infection and prevent its transmission. Patients undergoing hemodialysis are exposed to transfusion-transmitted infections, as is the case for healthcare professionals (Jabbar and Mohammed, 2021) [28]. About 11 percent of people with End-Stage Renal Disease (ESRD) die yearly due to the infection and the associated consequences. Hemodialysis patients are increasingly admitted to hospitals to receive treatment due to graft infection, a severe illness. Numerous studies have reported that five to fifteen percent of patients become infected due to their grafts. In the first year after the hospital admission, patients' risk of infection may be higher (Himmelfarb and Sayegh, 2010) [25].

Patients with ESRD receiving hemodialysis treatment are at

high risk of developing life-threatening infections. The infection leads to a significant morbidity rate and is second only after cardiovascular disease as a cause of death in patients with ESRD. Most bloodstream infections are associated with vascular access, mainly using a central venous catheter. In addition to bacterial infections, hemodialysis patients are susceptible to viral infections, including HBV, HCV, HIV, and influenza. Outbreaks of HCV infection in hemodialysis units continue to occur at an alarming frequency mostly due to poor infection control practices (Boyce and Vijayan, 2018) [16].

In the United States, more than 425,000 people are receiving maintenance hemodialysis. To undergo hemodialysis, patients must have vascular access, such as a catheter, an expanded blood artery, or a graft. Infections entering the bloodstream and the vascular access site in hemodialysis patients cause significant morbidity and death. Arteriovenous fistulas (AVFs), synthetic arteriovenous grafts, tunnelled central lines, and non-tunnelled central lines are four forms of hemodialysis vascular access that increase the risk of infection. Other catheter-graft hybrid devices may be used to get access to the body. Hemodialysis patients are particularly vulnerable to antibiotic-resistant bacterial infections because of how frequently they are admitted to the hospital and how many medications they must take. Keeping track of infection rates is essential for preventing diseases (Center for Disease Control and Prevention [CDC], 2022) [18].

Patients undergoing hemodialysis and nursing staff are at risk for HAIs caused by invasive therapeutic procedures. Most of these patients need at least one hospitalization annually to be protected against these infections. Deficient immune status, invasive hemodialysis treatment involving prolonged exposure to blood by reaching vessels and extracorporeal circuit, placing patients next to each other and between the hemodialysis machines during sessions, repeated hospitalization and surgery with immunosuppressive therapy, poor nutrition, and hyperparathyroidism and most importantly non-compliance of healthcare providers to follow standard precautions are all risk factors for patients that may increase the incidence of HAIs (Ahmed, Bayoumi and Hassan, 2019) [4].

Prolonged hospital stays, increased antimicrobial resistance, higher financial burdens for healthcare institutions, and higher costs for patients and their families, including the death of loved ones, are healthcare-related consequences that must be addressed. Healthcare-acquired infections significantly increase mortality and morbidity rates and boost treatment costs. Healthcare organizations need to improve patient care, monitor, and protect them from healthcare-acquired infections (Boyle, Donlon, Einarsdottir, McCann and Redmond, 2011) [17].

Patients with end-stage renal failure are more vulnerable to infection because of the increased exposure to infectious microorganisms caused by uremia. Infectious agents might also be transmitted since the technique requires extended durations of vascular access in the same setting and at the same time as other patients undergoing treatment. A higher risk of healthcare-acquired infections like blood-borne virus (BBV) or multi-resistant bacteria exists for dialysis patients who are often hospitalized and operated (Arduino, Nguyen and Patel, 2019) [10].

In hemodialysis centers, gloves are highly recommended since the nursing staff contacts the patient's skin or equipment. When HCWs begin to care for the next patient or move between stations, they should change their gloves and perform hand hygiene after each contact (Alkhaqani, 2022) [9]. If a sterile aseptic procedure such as vascular access insertion, catheter handling, or manipulation is required, then HCWs should wear sterile gloves (Adhikari and Attaulhaq, 2019) [3].

Significance of the study
The current study aimed to assess nurses' knowledge about infection control measures at hemodialysis units in Al-Najaf city hospitals in Iraq. The results showed that nurses' knowledge of infection control measures was moderate.

Materials and methods
Design of the study
The quantitative design (descriptive cross-sectional study) was used to achieve the objectives of this study. The study was conducted in Al-Najaf city hospitals in Iraq. Hospitals were selected (Al-Sadr Medical City; Al-Hakim General Hospital).

Sampling of the study
A non-probability (purposive) sampling was preferred to obtain representative and accurate data from 100 nurses working at hemodialysis units in Al-Najaf city hospitals (59 nurses from Al-Sadr Medical City and 41 nurses from Al-Hakim General Hospital).

Inclusion criteria
The researcher used the following criteria in determining the participants and mainly excluded nurses not meeting these criteria:
- The consent of all nursing staff working in the hemodialysis unit to participate in the study was obtained.
- All nursing staff members working in the hemodialysis unit who had an experience of at least one year were included.

Exclusion criteria
Some participants were excluded from the study for various reasons, including nurses with certain medical conditions, such as COVID-19, and long vacations, such as study leave and maternity leave, and those who did not respond to the study because they did not want to.

Data collection form
After obtaining approval for the study, the researcher adopted and developed a data collection tool (Rajih Q., 2020) [29] to achieve the study objectives. It consists of two following parts:
Part I: Socio-demographic Information of The Nurses. This part includes eleven questions about socio-demographic information of the nurses such as age, gender, level of education, residence, marital status, workplace, years of experience in hospitals, years of experience in hemodialysis unit, participation in training courses on hemodialysis units, participation in training courses on infection control measures, and doses of the hepatitis vaccine they got.
Part II: Knowledge of the Nurses Working in Hemodialysis Units about Infection Control Measures. The researcher prepared this part to evaluate the knowledge of the nurses working in hemodialysis units about infection prevention and control measures. It consisted of 39 multiple-choice questions.

This data collection tool covered the relevant points about the main content of the study. The number of correct answers was used to measure each nurse's knowledge level. They were rated as 2 points for correct answers and 1 point for incorrect answers.

Steps of data collection

The data collection process was carried out using the questionnaire between the first of March 2022 and ended on the thirtieth of April 2022. The consent of all the participants (100 nurses) was obtained to participate in the study and complete the questionnaire. The researcher held interviews individually with the nurses through the structured interview method using the Arabic version of the questionnaire. Each subject took approximately 15-30 minutes to complete the interview.

Statistical analysis

The data were analyzed using Statistical Package for Social Sciences (SPSS) version 20 and Microsoft Office 2016 (Word and Excel). The following statistical analysis methods were used for analyzing the results of the study: Descriptive Statistical Tests (Frequency, Percentage, Mean of Score, Standard Deviation, and Pearson correlation); Inferential Statistical Tests (One way ANOVA, paired sample T-test, and Chi-Square test).

Scoring study (mean of scores)

In nurse levels of knowledge, the assessment was done using the cutoff point equal to 0,33, and the knowledge levels were determined as follows: Poor knowledge (mean 1-1,33), Moderate knowledge (mean 1,34-1,67), and good knowledge (mean 1,68-2).

Ethical considerations

Approval was obtained from the Ethics Committee of Çankırı Karatekin University. Another approval was obtained from the Ethical Committee for Scientific Research Al-Najaf Health Directorate in the Iraqi Ministry of Health in Al-Najaf City after obtaining the permissions for the hemodialysis units in Al-Najaf city hospitals.

Results of the study

Table 1: The statistical distribution of the participants' socio-demographic information

Socio-demographic information	Rating and intervals	N	%
Age groups (Years)	<= 24	17	17
	25-29	47	47
	30-34	13	13
	35-39	12	12
	40 and more	11	11
	Mean ± SD	30,21 ± 7,6	
Gender	Male	38	38
	Female	62	62
Residence	Urban	93	93
	Rural	7	7
Marital Status	Single	32	32
	Married	68	68
Level of education	Nursing school	17	17
	Nursing Institute	26	26
	Nursing Bachelor	48	48
	Postgraduate in Nursing	9	9
Workplace	Al-Sadr Medical City / Kidney Diseases and Transplant Center	59	59
	Al-Hakim General Hospital / Artificial kidney	41	41
Experience in hospitals (Years)	<= 3	26	26
	4 - 6	45	45
	7 - 9	5	5
	10 - 12	5	5
	13 and more	19	19
	Mean ± SD	6,9 ± 6,3	
Experience in hemodialysis unit (Years)	<= 3	42	42
	4 - 6	36	36
	7 - 9	4	4
	10 - 12	9	9
	13 and more	9	9
	Mean ± SD	5,15 ± 5,1	
You took the full doses of the hepatitis vaccine	I took it	76	76
	I didn't take it	19	19
	I don't want to take the vaccine	5	5
Participate in training courses related to hemodialysis units	Yes	68	68
	No	32	32
Where participate in training courses related to hemodialysis units	No	32	32
	Inside Iraq	56	56

	Outside Iraq	0	0
	Inside and Outside Iraq	12	12
Number of training courses in hemodialysis units	<= 2	84	84
	3 - 4	14	14
	5 and more	2	2
	Mean ± SD	1,27 ± 1,3	
Duration of training courses in hemodialysis units (days)	<= 10	72	72
	11 - 25	16	16
	26 - 40	8	8
	41 and more	4	4
	Mean ± SD	9,87 ± 12,85	
Participate in training courses related to infection control measures	Yes	71	71
	No	29	29
Where participate in training courses related to infection control measures	No	29	29
	Inside Iraq	63	63
	Outside Iraq	0	0
	Inside and Outside Iraq	8	8
Number of training courses in infection control measures	<= 2	86	86
	3 - 4	11	11
	5 and more	3	3
	Mean ± SD	1,26 ± 1,28	
Duration of training courses in infection control measures (days)	<= 10	81	81
	11 - 25	11	11
	26 - 40	5	5
	41 and more	3	3
	Mean ± SD	8,68 ± 11,8	
Total		100	100%

Table 1 shows the socio-demographic information of the participants. According to the table, most of the participants were aged between 25 and 29 years, a great majority (62%) of them were female, and 93% were living in urban areas. When examining educational level, the study's findings revealed that most of the participants (48%) had a bachelor's degree in nursing. Regarding the years of experience in hospitals, it was found that most of the nurses (45%) had experience of 4 to 6 years in hospitals. In terms of participating in training courses on hemodialysis units and infection control measures, the study's findings revealed that the majority (68%) of the nurses participated in training courses, and the majority (56%) of these courses were located in Iraq.

Table 2: Assessment of nurses' levels of knowledge concerning infection control measures in the hemodialysis unit according to overall questionnaire items

Overall Items	Level	Frequency (N)	%	Mean	SD	Rating
Nurses' levels of knowledge regarding infection control measures	Poor	9	9%	1,499	0,15	74,95%
	Moderate	77	77%			
	Good	14	14%			
Total		100	100%			

***Abbreviations: SD=Standard Deviation; poor (mean of scores 1-1,33), moderate (1,34-1,67), good (1,68 and more), cutoff point (0,33).

Table 2 shows the assessment of the nurses' levels of knowledge of infection prevention measures in hemodialysis units. Responses for all the participants were average (moderate) with a rate of 74,95% with a statistical (Mean± Standard Deviation) of scores (1,499±0,15).

Table 3: Relationship between socio-demographic data and nurses' levels of knowledge according to socio-demographic categories in hemodialysis units

Socio-demographic information	Variables classes	Nurses' levels of knowledge			Chi-square (χ2)	p-value
		Poor	Moderate	Good		
Age Groups (Years)	<= 24	0	17	0	11,74	0,163
	25 - 29	4	36	7		
	30 - 34	1	9	3		
	35 - 39	1	8	3		
	40 and more	3	7	1		
Gender	Male	5	28	5	1,296	0,523
	Female	4	49	9		
Residence	Urban	8	72	13	0,264	0,876
	Rural	1	5	1		
Marital Status	Single	3	26	3	0,837	0,658

	Married	6	51	11		
Level of education	Nursing school	4	13	0	66	<0,001
	Nursing Institute	2	23	1		
	Nursing Bachelor	3	41	4		
	Postgraduate in Nursing	0	0	9		
You took the full doses of the hepatitis vaccine	I took it	6	57	13	3,258	0,516
	I didn't take it	2	16	1		
	I don't want to take the vaccine	1	4	0		
Workplace	Al-Sadr Medical City / Kidney Diseases and Transplant Center	4	43	12	5,23	0,073
	Al-Hakim General Hospital / Artificial kidney	5	34	2		
Experience in hospitals (Years)	<= 3	2	23	1	9,98	0,266
	4 - 6	3	35	7		
	7 - 9	0	4	1		
	10 - 12	0	3	2		
	13 and more	4	12	3		
Years of experience in hemodialysis unit	<= 3	5	36	1	13,58	0,093
	4 - 6	1	28	7		
	7 - 9	0	3	1		
	10 - 12	2	5	2		
	13 and more	1	5	3		
Participate in training courses related to hemodialysis units	Yes	5	48	14	8,18	0,017
	No	4	29	0		
Participants in training courses related to hemodialysis inside and outside Iraq	No	3	29	0	9,7	0,046
	Inside Iraq	5	41	10		
	Outside Iraq	0	0	0		
	Inside and Outside Iraq	1	7	4		
The number of hemodialysis courses	<= 2	6	69	9	9,331	0,06
	3 - 4	3	7	4		
	5 and more	0	1	1		
The duration of hemodialysis courses	<= 10	6	59	7	9,4	0,148
	11 - 25	2	11	3		
	26 - 40	0	6	2		
	41 and more	1	1	2		
Participate in training courses related to infection control measures	Yes	6	51	14	6,6	0,036
	No	3	26	0		
Participants in training courses related to infection control measures inside and outside Iraq	No	3	26	0	14,09	0,007
	Inside Iraq	5	48	10		
	Outside Iraq	0	0	0		
	Inside and Outside Iraq	1	3	4		
The number of infection control measures courses	<= 2	7	72	7	20,8	<0,001
	3 - 4	2	4	5		
	5 and more	0	1	2		
The duration of infection control measures courses	<= 10	7	70	4	31,9	<0,001
	11 - 25	1	4	6		
	26 - 40	1	2	2		
	41 and more	0	1	2		
Total		9	77	14		

***Abbreviations: *p*-value=probability value was calculated by using Chi-square (χ2); *= Significant if the *p*-value <=0,05, **= High Significant if the *p*-value <=0,01; and there is no significant difference if the letters are the same

Table 3 shows a statistically significant correlation between the nurses' levels of knowledge and socio-demographic information. Their level of knowledge was highly correlated with the level of education, the number of training courses on infection control measures, and the duration of training courses on infection control measures (Mean scores= 1,54, 1,51, and 1,57, respectively) (*P*<0,001). Their level of knowledge was highly correlated with their participation in training courses on hemodialysis units, with a mean score of 1,48 (P=0,017). Their level of knowledge was highly correlated with the participation in training courses on hemodialysis units inside and outside Iraq (the increased participation affected the correlation with the nurses' knowledge) with a a mean score of 1,51 (P=0,046).

Their level of knowledge had a high correlation with participation in training courses on infection control measures (the increased participation affected the correlation with the nurses' knowledge), with a mean score of 1,51 (P = 0,036). The nurses' levels of knowledge had a high correlation with participation in training courses on infection control measures inside and outside Iraq (the increased participation affected the relationship with the nurses' knowledge) with a mean score of 1,56 (P = 0,007).

Discussion of the study
The current study aims to assess nurses' knowledge of infection control measures in hemodialysis units.

Part I: Discussion of the socio-demographic information of the nurses

The current study's results showed that most nurses ranged from 25 to 29 years. This result was supported by the studies of Rajih (2020) [29] and Ayenew et al. (2018) [13], who reported that the majority of the participants were similar in age range. The researcher demonstrated that the hemodialysis unit needs 25 to 29-year-old nurses since they are more mature than other age groups.

When the gender of the nurses, it was found that many of the participants were female (62%). This result was confirmed by the study by Gharib et al. (2022) [21], which found that most participants were female. The researcher indicated that females are the dominant in each study, as he explained that females would need to work in hemodialysis units where they can perform jobs that require hard work because of the large number of female patients in those units.

Concerning the nurses' residence place, it was found that a high percentage of the participants (93%) were residing in urban areas like the city. This finding is incompatible with the study by Ibrahim, Salem and Soliman (2021) [27], who found that most participants were living in rural cities. In hemodialysis units in cities, the majority of their nursing staff were residing in urban cities due to the possibility of emergency cases requiring nursing staff throughout the day. In addition, when examining nurses' marital status, it was found that most participants were married (68%). This study is compatible with the study by Hassan and Faris (2016) [23], which showed that the percentage of married nurses was high. Regarding the participants' workplace, the study results showed that participants from dialysis units in Al-Sadr Medical City Hospital (59%) were more than participants from hemodialysis units in Al-Hakim General Hospital (41%). These results are compatible with the study of Hassan and Fares (2016) [23], where they indicated that the percentage of nursing staff working at Al-Sadr Medical City Hospital was more than that of those working at Al-Hakim General Hospital. Al-Sadr Medical City Hospital is considered one of the most critical health institutions in Al-Najaf City and contains 434 beds, followed by Al-Hakim General Hospital with 230 beds.

Regarding the educational level, the study's findings revealed that most of the participants had a bachelor's degree from the Nursing Faculty (48%). It is compatible with the study by Akhere, Alice, Grace, and Ikponwonsa (2013) [5], in which most of the participants graduated from the nursing faculty. In the study conducted by Abozead, Azer, and Morkes (2018) [1], in Egypt, more than two-thirds of nurses had a diploma from a nursing institute. The rate of participants in the study was high among those with bachelor's and postgraduate degrees in nursing. This has led to increased knowledge due to these groups' higher theoretical and practical aspects of infection control measures.

When examining the duration of working in the hospitals, it was determined that the majority of the participants (45%) were working in the hospitals for 4 to 6 years. A similar study by Bakey (2012) [14] reported that most of the participating nurses had experience of 1 to 5 years working in hospitals. Regarding the duration of working in hemodialysis units, the majority of the nurses included in the current study (42%) had an experience of less than or equal to three years of working in hemodialysis units. The study's findings are compatible with

Albaghdadi et al. (2020) [6], who determined that most nurses had experience of 1 to 3 years in hemodialysis units. The duration of working in hospitals and hemodialysis units plays an important role in improving the knowledge and practices of the nursing staff because the majority of the participants were between the ages of twenty-five and twenty-nine years old. Most had an average experience of four to six years, so they required more time and practical and theoretical training in the fields of hemodialysis and infection control measures.

When analyzing the hepatitis vaccinations of the nurses, it was found in the present study that 76% of them were vaccinated, which indicates their excellent knowledge of vaccines. It is compatible with the study by Hasandokht, Joukar, Mansour-Ghanaei, and Naghipour (2017) [24], which found that most nurses were vaccinated with full doses of hepatitis vaccines.

Concerning the participation of the nursing staff in training courses on hemodialysis units, the study's findings indicated that 68% of the nursing staff participated in training courses on hemodialysis units, 56% participated in training courses on hemodialysis units within Iraq, 84% participated in several courses less than or equal to two courses, and 72% of them participated in the training courses of ten days. The study results are incompatible with those of Ibrahim, Ismail, and Ouda (2019) [26], who found that most of the nursing staff did not participate in training courses on hemodialysis units. The researcher indicated that the nursing staff's active participation in dialysis training courses improved their specific knowledge and provided the best practices and skills for the patients regarding implementing preventative measures.

Regarding the participation of the nurses in training courses on infection prevention and control measures, the study revealed that the majority of them (71%) participated in training courses on infection prevention and control measures, and 63% participated in training courses inside Iraq. 86% of the nurses participated in training courses of less than or equal to two courses. 81% of the nurses received training courses in a period of ≤ ten days. The results of the study are different from those of Jabbar and Mohammed (2021) [28]'s study, who reported that most of the nurses did not receive training courses in this field; in addition, another study conducted by Ayed, Eqtait, Fashafsheh, and Harazneh, (2015) in Palestine to evaluate the level of knowledge and practices on infection control among nurses in Palestine Governmental Hospital revealed that the majority of nurses did not participate in training courses on infection control measures. This is due to how weak nursing training is and nurses overlooking the importance of learning about infection control measures. Participation of nursing staff in infection control training courses in hemodialysis units is critical to prevent infection transmission between hemodialysis staff and patients, including blood-borne infection and virus transmission. Nursing staff must be trained by participating in infection control training courses and implementing the function of the infection control nurse in these units.

Part II: Discussion of the study sample's assessment of nurses' levels of knowledge about infection control measures at a hemodialysis unit, according to the study sample

The study mainly consisted of one study to assess the knowledge of infection prevention and control measures among nurses working in hemodialysis units.

The study's findings showed that the participants had average (moderate) knowledge about infection control measures, 74.95%, which means that the nurses needed a higher level of knowledge regarding infection prevention measures in the hemodialysis units. The large majority of the nursing staff didn't participate in training courses on infection control measures in hemodialysis units.

These findings are compatible with those of studies conducted by Athbi and Mohammed (2012) and Jabbar and Mohammed (2021) [28], reporting that the education program effectively improved the knowledge of the participating nurses. Another study by Elashir, Maghraby, Mahmoud, and Yousef (2019) indicated that implementing education programs significantly improved the nurses' knowledge about infection control measures. The researcher stated that health and education officials should enhance the knowledge and practices of training activities about infection control measures for healthcare workers, especially nursing staff working in hemodialysis units, by activating preventive infection control programs and adhering to World Health Organization and Center for Disease Control guidelines.

Another study performed in the Republic of Korea by Chun, Kim, and Park (2012) confirmed that the program developed for hemodialysis nurses positively affected the knowledge and practices of hemodialysis nurses. This means that theoretical and practical training programs on infection control procedures in hemodialysis units are of primary importance in improving the skills of nursing staff through the application of infection control guidelines such as washing hands, wearing protective equipment, isolating medical waste, sterilization, and cleaning to reduce the risk of infection for the patient and the staff working in those units and the community.

Part III: Discuss the relationship between socio-demographic information and nurses' knowledge levels according to hemodialysis units' socio-demographic categories

The study revealed a high statistically significant correlation between the nurses' knowledge level and their socio-demographic information.

The study indicated a statistically significant correlation between the nurses' knowledge and education levels (p-value: < 0,001). The study also showed a high correlation between nurses with postgraduate studies in nursing (Master's and Doctorate in Nursing), as they had good knowledge. This finding is compatible with the study by Jabbar and Mohammed (2021) [28], which found a highly statistically significant correlation between the education level and the knowledge of the nursing staff. The findings contradicted Bayoumi and Mahmoud (2017), who discovered a high-level positive correlation between nurses' total practice and their data. The study found no statistical correlation between nurses' knowledge and personal data after applying for the educational program.

The study's results also showed a statistically significant correlation between the nurses' knowledge and the variable of participating in training courses on the hemodialysis unit ($p<0,05$). A statistically significant correlation was found between the knowledge of the nurses and the training courses on hemodialysis units inside and outside Iraq ($p<0,05$). This indicated that participation in training courses on hemodialysis units improved nurses' knowledge of infection prevention and control measures. These results are incompatible with the study by Ibrahim *et al*. (2019) [26], who revealed that two-thirds of the nursing staff did not participate in training courses specialized in hemodialysis. The researcher explains a significant correlation between the hemodialysis training courses and infection control procedures and their positive effect on the knowledge of the nursing staff working in those units.

When it comes to participation in training courses on infection control and prevention measures, it was found that there was a statistically significant correlation between the knowledge of nurses and this variable ($p<0,05$). The study also showed a statistically significant correlation between the knowledge of the nurses and their participation in training courses on infection control measures inside and outside Iraq ($p<0,05$). The knowledge of the nurses was statistically significantly correlated with the number of courses and the duration of those training courses ($p<0,05$). This study is compatible with the study entitled "Knowledge, Attitude, and Practice of Standard Infection Control Precautions by Hospital Staff in Two Class III Hospitals in Nigeria" conducted by Adetunji *et al*. (2015) [2] in the Nigeria Republic which indicated that most of the nursing staff attended training courses on infection control. These results contradict the results of the study by AL-Kerity and Naji (2017) [7], who revealed that most of the participants did not attend training courses on infection control because the majority of the participants were newly appointed to the job, they were not well experienced, and there was lack of educational activities in these institutions.

When examining age groups, gender, residence, marital status, getting the hepatitis vaccine, workplace, years of experience in hospitals, and years of experience in hemodialysis units, the results showed no statistically significant correlation between the nurses' socio-demographic information and level of knowledge. But logically, years of experience in hospitals and hemodialysis units should have an essential role in infection control and prevention measures; this result may be because the nursing staff was participating in the study in the hemodialysis unit, 64% of newly hired employees with an average age of fewer than 29 years may not rely on evidence-based practices or updated references in their practices. These results are compatible with the study conducted by Gijare (2012) [22] in India, which showed the effectiveness of teaching procedures for infection control among healthcare workers. There were no significant differences in the levels of knowledge and practices between age and years of experience. Also, this study is not compatible with the study by Al-Mawsheki, Ibrahim, and Taha (2016) [8], who reported a statistically significant correlation between years of experience and nurses' performance in hemodialysis units; half of the nurses had one to less than ten years of experience, and the most of the nurses received training courses on patient care in the hemodialysis unit. In comparison, 95% of those who attended the training courses benefited from them.

Conclusions of the study

The researcher concluded, through the results of his current study, that the percentage of knowledge amounted to about 74.95% and was (moderate) level. There was a highly statistically significant relationship between nurses' cognitive levels and social and demographic information (level of

education, participation in training courses related to dialysis units inside and outside Iraq, participation in training courses related to infection control procedures inside and outside Iraq, number of infection control courses, and duration of infection control courses).

Recommendations of the study

The study recommended the necessity of activating the role of continuing nursing education in hemodialysis units in order to give courses on infection control measures for all nursing staff working in those units, as well as activating the National Program for Infection Control in Iraqi Health Facilities (2009) and updating it in cooperation with the World Health Organization and Centers for Disease Control and Prevention.

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