



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

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJMAH/2019/v14i430109

Editor(s):

(1) Dr. Darko Nozic, Professor, University of Belgrade, Serbia.

Reviewers:

(1) Dr. Sayan Bhattacharyya, AIIMS Patna, India.

(2) Dr. Arun Singh, MJP Rohilkhand University, India.

(3) Mona El Shokry, Ain Shams University, Egypt.

Complete Peer review History: <http://www.sdiarticle3.com/review-history/31835>

Original Research Article

Received 08 December 2016

Accepted 16 February 2017

Published 18 April 2019

ABSTRACT

Objective: Infection is a leading cause of hospitalization and the second most common cause of mortality among hemodialysis (HD) patients. The aim of this study is to assess the impact of infection prevention and control education program on improving healthcare workers knowledge, attitude and practices and reducing incidence of infection in the hemodialysis unit.

Methodology: All patients and healthcare workers in the unit within the study period were included. This study was conducted through 3 phases; Phase I: base line survey for assessment of infection prevention and control knowledge, attitude and practices among healthcare workers, Phase II: Intervention that included infection control standardized education program followed by post education survey. Phase III: Implementation of infection control program was done associated with

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assessment of blood born viruses (HCV, HBV & HIV) and monitoring patients for fever and/or local signs of inflammation at catheter exit or at skin around shunt to be subjected to blood culture.

Results: Health care workers knowledge, attitude and practices of infection prevention and control before intervention were unsatisfactory followed by significant improvement reflecting the effectiveness of such interventions. Regarding incidence of infection there were three cases of blood stream infections; two of them were multidrug resistant organisms (MDROs) and no reported cases of seroconversion for HIV, HCV or HBV during study period.

Conclusion: Lack of knowledge about infection prevention and control practices in hemodialysis unit could be significantly improved by standardized education program which results in reducing incidence of infections in such units.

Keywords: Hemodialysis; infection control; education; healthcare workers.

1. INTRODUCTION

Chronic renal failure is considered one of the public health problems all over the world that associated with poor quality of life [1].

The international incidence of chronic renal failure has been increased and its incidence to progress to end stage is expected to be the double during next 15 years [2,3].

The demand for renal replacement therapy, as the treatment option for end stage renal disease has increased which in turn becomes a significant load on healthcare structure and process [1].

Infection is the leading cause of hospitalization and the second leading cause of mortality among patients on hemodialysis [4].

The mortality from hemodialysis related causes is found to be 7 times more than mortality in normal population [5].

There are many types of infections that could affect HD patients including; exposure to blood borne pathogens, blood stream infections with increased risk of invasive diseases caused by multidrug resistant organisms (MDROs), localized vascular access infections [6].

Risk factors for infection in HD patients include compromised immune status, exposure to invasive devices, frequent and prolonged blood exposure during hemodialysis process, contact with healthcare personnel who usually provides care to more than one patient and moves between different machines, and most significantly, non adherence or more frequently defect in implementation of the recommended guidelines [7].

This defect in implementation process is multifactorial and occurs mainly as a result of understaffing, lack or inadequate training of HD staff, lack of resources, and overcrowded units with inadequate spacing between patients [8-10].

Establishing an infection prevention and control program which includes a bundle of strategies and interventions that are consistently performed will reduce the infection risk for both healthcare workers and patients. So, the aim of this study is to evaluate the knowledge, attitude and practices of infection prevention and control of the healthcare workers in hemodialysis unit before and after education and training and impact on the incidence of infection during the period of follow up.

2. METHODS

2.1 Study Design

A pilot study using a pre- and post-test design prior to and at the completion of an education intervention.

2.2 Study Setting and Subject

The study was conducted in hemodialysis unit in tertiary care facility at Egypt over a period of one year divided as follows:

- Two months: preparation, pre intervention test and analysis for defect.
- Three months: materials preparation and training using evidence-based guidance on aspects of infection control in hemodialysis units through scheduled lectures, posters and workshops for each group of healthcare workers and post intervention test.

- Six months: implementation and follow up for detection of cases with healthcare associated infections.
- One month for final evaluation and statistical analysis.

All healthcare staff in the unit including 8 doctors, 28 nurses and 6 workers was subjected to assessment of their infection control knowledge, attitude and practices through questionnaire and observation using observation checklists that were derived from:

- 1- Centers for Disease Control and Prevention. Recommendations for preventing transmission of infections among chronic hemodialysis patients [11].
- 2- WHO hand hygiene checklist

All new and old patients attending the unit for hemodialysis (3 sessions per week at fixed days, divided in 3 fixed groups per day and every session is 4 hours).

All patients attended the dialysis unit at the period of the study was investigated as follows:

- 1- Complete history taking for chronic diseases and previous infections in the last year.
- 2- Investigations of blood born viruses were done at the start of dialysis. ALT (alanine aminotransferase) was tested monthly and anti HCV every 3 months for follow up of seroconversion in anti HCV negative patients. Patients who were HBV susceptible including non responders to vaccine were tested monthly for anti HBs while those with positive anti HBs (≥ 10 m IU/ml) and negative anti HBC were tested annually.
- 3- Local signs of inflammation at catheter exit or at skin around shunt and associated fever.

The study was divided to 3 phases:

Phase I: preparation period and pre intervention test using questionnaire for assessing knowledge, attitude and practice of staff about standards of infection prevention and control using two models of sheets one for doctors and nurses, and the other for sanitation workers. Degree of knowledge was ascertained by means of yes–no questions on certain items, whereas the others were to put a group of events in their correct order. CDC Observation checklists [12] were also used to assess infection control

practices in nurses of hemodialysis unit. Base line assessment of hand hygiene compliance was done using WHO Checklist.

Phase II: The intervention program that was designed according to the results of the pre-test. Education and training intervention on the selected topics was prepared using evidence-based guidance [11,13] on aspects of infection prevention and control in hemodialysis unit. Educational materials were prepared, reviewed before using them.

Sixteen educational sessions were delivered over two months, with the participants divided into different groups, so that some participants' attended the sessions in the morning from 10:00 am to 11:00 am, while others attended in the evening from 5:00 pm to 6:00 pm.

The methods used in the intervention program included: lectures, posters, group discussions, videos and workshops. The contents of the sessions of the education intervention program were as follows:

- Hand hygiene
- Proper use of protective equipment.
- Modes of transmission for bloodborne viruses, pathogenic bacteria, and other microorganisms.
- Infection control practices recommended for hemodialysis units in addition to standard precautions
- Proper handling and delivery of patient medications.
- Safe injection.
- Rationale for segregating HBsAg-positive patients with a separate room, machine, instruments, supplies, medications, and staff members.
- Bundles of care for vascular access.
- Environmental cleaning and disinfection.
- Disinfection of hemodialysis machines.
- Routine serologic testing results for HBV and HCV.
- Hepatitis B vaccination for both patients and healthcare staff.

This education intervention was followed by immediate post intervention test using the same tools of the pre test.

Phase III: Implementation of infection control program, then follow up for evaluating the impact of intervention on practices of the healthcare workers and the incidence of

infection. This phase lasted for six months. Post intervention hand hygiene compliance rate was assessed.

During this phase, each patient was checked for local signs of inflammation at catheter exit or at skin around shunt and associated fever that not caused by infection at another site. Patients expected to have blood stream infection were subjected to blood culture followed by repeated subcultures for isolation, identification and antibiotic sensitivity of the isolated organism. Microbiological study was carried out at Medical Microbiology and Immunology, Tanta Faculty of Medicine, Egypt.

Investigation of blood borne viruses (HCV & HIV) was done on first admission and every 3 months, while HBV was checked on first admission and repeated monthly.

2.3 Ethical Considerations

- Approval of hospitals administrators was taken.
- Informed consent was taken from all participants in the study.

2.4 Statistical Analysis

Data was organized, tabulated and statistically analyzed using SPSS software statistical package version 19. Numerical variables were presented as mean and standard deviation while categorical variables were presented as number and percentage. Differences between categories of each variable pre and post interventions were statistically analyzed using Z test. The level of significance was adopted at $p < 0.05$.

3. RESULTS

The following Tables 1-5 show demographic data of healthcare workers at the unit under study and the results of their knowledge and practices of infection prevention and control in HD units through the three phases of the study including pre-test, post-test immediately after intervention, and incidence of infection and hand hygiene compliance six months later.

Regarding the incidence of infection at the end of post intervention follow up period (six months), it was found that:

1. Results of blood borne viruses (HCV, HBV & HIV) investigations on HD patients showed no cases with seroconversion during the period of study.

2. Results of blood culture for cases suspected to have vascular access associated blood stream infection showed 3 positive cultures from 3 patients with central venous catheters with the following isolated organisms:

- ESBL-producing *Proteus vulgaris*
- ESBL-producing *Enterobacter* spp.
- *Candida albicans*

The incidence of vascular access associated blood stream infection was calculated as follows:

Number of new and old cases with blood stream infection/ total number of patients attending the HD unit for hemodialysis $\times 100 = 3/95 \times 100 = 3.2\%$.

4. DISCUSSION

Regarding knowledge of healthcare workers in unit under study before and after the intervention about modes of bloodborne infection transmission, only (11.9%) of them had correctly answered that contact of contaminated blood with intact skin is not a mode of bloodborne infections transmission, representing poor knowledge regarding that issue. On the other hand, there was a good knowledge about other causes of transmission including contact of a spray of body fluids with mucous membranes and needle puncture or other sharp instruments (Table 2).

These results are in agreement with Abou El-Enein et al. [14] who reported that (82.4%) of healthcare workers mentioned that splashing of a patient's body fluids in a healthcare worker's eye represents a risk for systemic infection only if the patient has a known infection, and knowledge significantly increased to (100%) after intervention.

Majority of the staff (88.1%) had known that puncture with needle of hepatitis C patient may lead to hepatitis C infection and knowledge significantly increased to (100%) after intervention. Similarly, Petrosillo et al. [15] reported that, HCV transmission from patient to patient can occur through contaminated HD equipment or through contaminated environment like nurses' hands, tables, chairs, clamps, door knobs, blood pressure apparatus, tourniquet, multi dose vials. Froio and Nicastrì [16] stated that to minimize this risk, it is essential to adhere to the standard infection control measures according to the international guidelines. In

addition, Meyers et al. [17] stated that regular and education of the staff are essentially serologic testing, active surveillance, training required.

Table 1. Demographics of the studied healthcare staff

Variables	Number (n=42)	Percentage
Job:		
Specialist assistant	4	9.5
Resident	4	9.5
Specialized nurse	20	47.7
Nurse	8	19.0
Worker	6	14.3
Qualifications:		
Master/Diploma of Medicine	4	9.5
Bachelor of Medicine	4	9.5
Bachelor of nursing	20	47.7
Diploma of high institute of nursing	2	4.8
Diploma of technical school of nursing	6	14.3
Technical diploma	3	7.1
None	3	7.1
Years of experience:		
<2	10	23.8
2-5	13	30.9
>5-10	12	28.6
>10	7	16.7
Range	1-38	
Mean+SD	6.17+7.21	

Table 2. Evaluation of the studied healthcare staff in relation to correct answers for knowledge about modes of bloodborne infection transmission and selected infection control practices before and after the intervention

Modes of bloodborne infection transmission	Before intervention		After intervention		Z	P
	n	%	N	%		
- Contact of contaminated blood with intact skin	5	11.9	42	100.0	6.083	0.001*
- During pregnancy, delivery or lactation	32	76.2	42	100.0	3.162	0.002*
- The arrival of a spray of body fluids with mucous membranes	26	61.9	42	100.0	4.000	0.001*
- Wounds as a result of needle puncture or other sharp instruments	35	83.3	42	100.0	2.646	0.008*
- Needle puncture of patient infected with hepatitis C may lead to infection with hepatitis C	37	88.1	42	100.0	2.236	0.025*
- In the case of needle puncture or sharp instrument injury, wash the wound with soap and water and prompt reporting to occupational health office	35	83.3	42	100.0	2.646	0.008*
- All workers in the unit should be vaccinated against the viral hepatitis B	42	100.0	42	100.0	0.000	1.000
- Environmental cleaning of blood spills using chlorine and its correct concentration	3	7.1	42	100.0	6.245	0.001*
- It is necessary to get rid of the bags containing medical waste after each session	34	81.0	42	100.0	2.828	0.005*
- It is necessary to get rid of the safety boxes when up to three-quarters	19	45.2	42	100.0	4.796	0.001*

* Significant ($p < 0.05$)

Table 3. Evaluation of the nurses and doctors knowledge in relation to correct answers regarding policies of HCV patient isolation, HBV vaccination, basic principles of hemodialysis unit construction and water system, dealing with patient vascular access, and safe injection before and after the intervention (n=36)

Variables	Before intervention		After intervention		Z	P
	N	%	n	%		
- Customize separate machines for HCV patients	34	94.4	36	100.0	1.414	0.157
- Do ALT monthly and serological tests / 3 months and follow-up seroconversion for HCV	12	33.3	36	100.0	3.162	0.002 [*]
- Customize tools and team for HCV patients	30	83.3	36	100.0	2.646	0.001 [*]
- Knowing correct timing of doses hepatitis B vaccine series	29	80.5	36	100.0	2.828	0.005 [*]
- Knowing correct timing for post vaccination testing for HbsAb	14	38.8	35	97.2	4.811	0.001 [*]
- Samples of the water used in dialysis Must collect during the process of dialysis or just after ending	10	27.8	36	100.0	5.099	0.001 [*]
- Periodic tests for water "microbiological and chemical" monthly	5	13.9	36	100.0	5.568	0.001 [*]
- Total viable microbial count should not exceed 200 CFU/ml	8	22.2	35	97.2	5.209	0.001 [*]
- Correct order of arteriovenous fistula/ graft cannulation	16	44.4	26	72.2	3.162	0.002 [*]
- Correct order of arteriovenous fistula/ graft decannulation	17	47.2	27	75.0	3.162	0.002 [*]
- Correct order of hemodialysis catheter connection	13	36.1	22	61.1	3.000	0.003 [*]
- Correct order of hemodialysis catheter disconnection	14	38.9	21	58.3	2.646	0.008 [*]
- Medications and solutions should be dedicated for use once on a single patient	30	83.3	36	100.0	2.646	0.008 [*]
- Multi-dose medication should be assigned to a single patient & use sterile syringe and needle each time	8	22.2	35	97.2	5.209	0.001 [*]

* Significant ($p < 0.05$)

Table 4. Pre and post intervention evaluation of good practice of nurses concerning dealing with vascular access using CDC observation checklist (n=28)

Items of practice	Before Intervention		After intervention		Z	P
	n	%	N	%		
- Arteriovenous fistula/ graft cannulation	17	60.7	24	85.7	2.646	0.008 [*]
- Arteriovenous fistula/ graft decannulation	18	64.3	32	82.1	2.236	0.025 [*]
- Correct order of Hemodialysis catheter connection	21	75.0	24	85.7	1.732	0.083
- Correct order of Hemodialysiscatheter disconnection	15	53.6	23	82.1	2.828	0.005 [*]
- Hemodialysis catheter exit site care	16	57.1	23	82.1	2.333	0.020 [*]

* Significant ($p < 0.05$)

Regarding knowledge of healthcare workers about practices related to infection control in the studied HD unit before the intervention, there was a good knowledge about both dealing with needle puncture or sharp instrument injury, and the importance of vaccination against hepatitis B

virus to all the workers in the unit. On the other hand, there was poor knowledge about dealing with blood spills and also unsatisfactory performance as (45.2%) of them had known that it is necessary to get rid of the safety boxes when up to three-quarters (Table 2).

Table 5. Pre and post intervention hand hygiene compliance rates in doctors and nurses by observing WHO's 5 Moments of hand hygiene (HH) actions and opportunities

Healthcare worker	Before intervention (base line observation)			After intervention			Z	P
	Actions of HH (A)	Opportunities of HH (B)	Compliance (%) (A/B)	Actions of HH (A)	Opportunities of HH (B)	Compliance (%) (A/B)		
Nurses (n=28)	314	1361	23.1%	456	1105	41.3%	9.696	0.0001*
Doctors (n=8)	116	533	21.7%	98	405	24.2%	0.879	0.189

These results were in accordance with a similar study conducted in Al-Mansoura University Hospital in Egypt in which nurses were found to have unsatisfactory knowledge regarding waste management before the implementation of education program [18].

On the other hand, Kabbash et al. [19] reported that higher percentage of governmental unit workers had good knowledge about methods of safe disposal of contaminated articles (98.7%) than workers in private units (8.5%). Also, studies done by Goddu et al. in England and India hospitals [20], and Saini et al. [21] at a tertiary level hospital in India, revealed higher level of nurses' knowledge about waste management.

Testing knowledge of the healthcare staff at the unit under study about policies of HCV patient isolation and HBV vaccination (Table 3) showed that there was a good knowledge about customizing separate machines, tools, and team for HCV patients, this occurs in almost all HD centers and units in Egypt and it is not in accordance with the guidelines stated that isolation of HCV infected patients is not recommended as an alternative to strict infection-control procedures [22]. This may happened because HCV is endemic in Egypt and also due to lack of adherence to infection control procedures.

Only (33.3%) of them knew when to do serological tests for follow-up of serological conversion for HCV patients. This was not in agreement with the study of Bianco et al. [22] in which they found good knowledge of nurses about timing of HCV serological testing for follow up of seroconversion. Knowledge significantly increased to (100%) after intervention.

Regarding hepatitis B vaccination, there was a good knowledge about timing of hepatitis B vaccination series among healthcare staff and

unsatisfactory knowledge about post vaccination serological testing and its timing. This result is in agreement with El Kabbash et al. [19] who reported high percentages of workers who had previous vaccination against hepatitis B virus in a private dialysis unit and hence had good knowledge about timing of vaccine series. The Egyptian Ministry of Health and Population in Egypt (MOHP) offers vaccination for health care workers who are employed in high-risk settings such as hemodialysis. But, there is lack of an orientation program, lack of the participants' awareness with the availability of this vaccine.

When testing the knowledge of doctors and nurses about the basic principles of HD unit construction and water system, the results indicate unsatisfactory knowledge and practice about water system and ignorance of the important role of safe water in preventing infections in such critical units according to the guidelines and knowledge significantly increased to (100%) after intervention. These results are in agreement with Tokars et al. [23] who reported that infections caused by contaminated water and equipment can be prevented by routine bacteriologic monitoring of dialysis water and dialysis fluid.

Regarding knowledge of doctors and nurses about dealing with patient vascular access and safe injection before and after the intervention. It was found that the results illustrated in (Table 3) showed relatively unsatisfactory knowledge of best practice of vascular access in the pre test which may lead to increase the risk of infection that followed by significant improvement in the post intervention test. These results were in accordance with Higgins and Evans [24] who found that inspite of the presence of infection control education program, knowledge and practice, nurses are still in need for significant improvement. Moreover, there was unsatisfactory knowledge about best practice for multi-dose medication in the pre test and was

significantly improved after intervention. Also, Enwere and Diwe [25] found poor knowledge base of the healthcare staff about safe injection practices that improved after educational intervention.

It was found that (47.7%) of nursing staff had bachelor degree of nursing and this reflects better ability for education and training as they were highly motivated to know correct answers for questionnaire. Moreover, time interval between pretest and post test was not so long and using questionnaire for assessment of the staff by means of yes –no questions on some items and arrangement in correct order in other items make it more easy to get the correct answer in post test. These factors may explain the change of the results to (100%) in most knowledge parameters after the intervention.

Regarding practice of the nurses in dealing with patient vascular access in HD unit under study before and after the intervention using CDC observation checklists (Table 4). Results illustrated in the table showed that (53.6% -75%) of the nurses in the unit under study were adherent to best practices related to dialysis process including vascular access care during pre intervention survey that was significantly improved after the intervention. This result was in accordance with El-Moghazy et al. [26] who reported that the performance of nurses in steps of dialysis process including vascular access care was significantly increased after intervention.

These results denote that strict observation of nurses during work for continuous evaluation of their practice with correction of poor practices is one of the most important aspects to insure quality of patient care. After enough period of strict supervision, the standard practices become the routine practice for healthcare workers.

In this study, baseline hand hygiene compliance rate was unsatisfactory in both nurses and doctors (Table 5). This was followed by significant improvement in nurses and non significant improvement in doctors after intervention. In accordance with this study, it was observed that over all hand washing adherence was often less than 50% in studies carried out during the last 20 years [27]. Poor adherence may be attributed to lack of education and training about the importance of hand hygiene, lack of resources, and also understaffing in overcrowded shifts.

Also, the degree of compliance was monitored in nine Spanish hemodialysis units in the study by Arenas et al. [27] who observed that hand washing was significantly lower when the number of patients attended by nurses was higher, and when there were more shifts per day. The researchers concluded that one of the factors that can contribute to noncompliance is time limitation as staff having to work in a hurry because shifts follow each other closely and because the time table has to be strictly adhered to [28].

Our results were in agreement with Scheithauer et al. [29] who showed baseline low hand hygiene compliance during hemodialysis treatment which was significantly improved after educational intervention. Also Tyson and York [30] stated that the significant improvement in nurses' knowledge after attending a program emphasized the need of hospital nurses to attend more educational opportunities to strengthen their skills and update their knowledge and improve the quality of care provided to patients. This study results agree with Abou Shady et al. [31] who found that despite health workers awareness of the practice requirement and legislation governing hand washing, compliance was quite poor and stated that the main cause behind the non application of universal precautions in Egypt were the shortage of equipment and supplies.

During implementation period three patients had blood stream infection (BSI) and all of them had haemodialysis central venous catheter. After bacteriological study for identification of the causative agent followed by antibiotic susceptibility testing, they were found to be multidrug-resistant organisms (MDROs). These results were in agreement with Dopirak et al. [32] who stated that rates of BSI in patients undergoing hemodialysis appear to vary depending on the type of vascular access. Patients who have a central venous catheter (CVC) are at a higher risk for BSI than those with other forms of access [33]. The BSI rate in National Healthcare Safety Network (NHSN) for patients with permanent CVCs was approximately 4.2 per 100 patient-months compared with 0.9 and 0.5 per 100 patient-months, for patients with arteriovenous (AV) grafts and AV fistulas respectively [34].

In this study there were two cases infected with multidrug-resistant Gram-negative bacilli (representing 66.6% of BSI cases). The

proportion of strains resistant to antimicrobials had increased to approximately 27% in NHSN in 2006 and 2007 [35]. More recent studies have also suggested high rates of colonization with MDROs in hemodialysis patients [36]. In an analysis of data from a CDC funded surveillance system for invasive MRSA infections, Lucero and colleagues found that the risk for invasive MRSA infections was more than 100-times higher for patients on dialysis than for the general population [6].

5. CONCLUSION

Based on the results of the present study, there was a significant improvement of healthcare staff knowledge about infection prevention and control principles in the hemodialysis unit under study immediately after implementation of an educational intervention program denoting the effectiveness of such intervention. Moreover, the study showed that there was a significant improvement of nursing staff practice in relation to hand hygiene compliance during six months follow up after implementation of educational intervention program in contrary to doctors who showed insignificant improvement in hand hygiene compliance. The most striking obstacles that interfere with more satisfying results in our country is lacking of resources, inadequate knowledge and training regarding infection control guidelines, and understaffing due to overcrowded healthcare facilities.

CONSENT

As per international standard or university standard, patient's written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

As per international standard or university standard, written approval of Ethics committee has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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