



Korean clinical practice guidelines for preventing the transmission of infections in hemodialysis facilities

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Patients receiving hemodialysis are vulnerable to infectious diseases due to their impaired immunity and high risk of exposure to pathogens. To protect patients, staff, and visitors from potential infections, each hemodialysis unit should establish and follow standard infection control and prevention measures. Therefore, clinical practice guidelines were developed by a working group of nephrologists and infection control specialists to provide evidence-based guidance for dialysis physicians and nurses, with the aim of preventing infection transmission and controlling infection sources in hemodialysis facilities. The areas of infection control covered by these guidelines include standard precautions, isolation strategies, vascular access, water treatment, cleaning/disinfecting/sterilizing, and vaccination. This special report summarizes the key recommendations from the Korean clinical practice guidelines for preventing the transmission of infections in hemodialysis facilities.

Keywords: Hemodialysis units, Hospitals, Infection control, Practice guideline

Introduction

Patients with end-stage renal disease (ESRD) are vulnerable to infectious diseases due to their impaired immunity and high risk of exposure to pathogens. Dialysis patients are prone to blood-borne infections transmitted through needles, transfusions, and dialysis catheters.

Therefore, it is very important to establish infection control measures to prevent the transmission of pathogens in hemodialysis facilities. Unfortunately, no such infection control recommendations have been made available to hemodialysis facilities in Korea. Even a few international recommendations have not been readily applicable to hemodialysis facilities in Korea. Therefore, an expert group composed of nephrologists and infection control specialists drafted and developed the current clinical practice guidelines based on relevant practical issues.

The purpose of this report is to provide evidence-based guidance for dialysis physicians and nurses to prevent the transmission of infections and control infection sources in hemodialysis facilities. The target population covered by the current guidelines includes adult ESRD patients over 18 years old who are receiving hemodialysis therapy in dialysis units. The areas of infection control covered by

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these guidelines include standard precautions, isolation strategies, vascular access, water treatment, cleaning/disinfecting/sterilizing, and vaccination.

As in the previous guidelines issued by the Korea Centers for Disease Control and Prevention and the Korean Society of Healthcare-associated Infection Control and Prevention, each recommendation has been categorized as either Category I (strong recommendation) or Category II (weak recommendation) on the basis of evidence levels, benefits/risks, and clinical applicability in the medical field. The grade of recommendation was adjusted when the performance level of the recommendation was expected to be low even though the level of evidence was high. In addition, based on an external review, some recommendations that did not fully reflect the domestic medical situation and caused conflicts of interest were not graded, and have been classified as unresolved issues.

The guidelines recommended by the expert group on infection control (or by other sources) are listed and discussed below, after the 12 principles of infection control. The categories for each grade of recommendation are stated within parentheses and are defined in Table 1.

Recommendations

1. Infection prevention and control program
2. Hand hygiene
3. Isolation strategies
4. Infection prevention during the dialysis procedure
5. Control of the source of blood-borne infections
6. Infection control for vascular access
7. Water treatment
8. Waste management
9. Sterilizing, disinfecting, and cleaning
10. Laundry care
11. Environmental control
12. Vaccination

Table 1. The system for categorizing recommendations

Level of evidence		
Code	Level of evidence	Definition
A	High	Further research is very unlikely to change our confidence in the estimate of effect.
B	Moderate	Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
C	Low	Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
D	Very low	Any estimate of effect is very uncertain.
Grade of recommendation		
Category	Definition	
IA	Strongly recommended for implementation and strongly supported by well-designed experimental, clinical, or epidemiologic studies	
IB	Strongly recommended for implementation and supported by some experimental, clinical, or epidemiologic studies and a strong theoretical rationale; or an accepted practice supported by limited evidence	
IC	Required by national regulations, rules, or standards	
II	Suggested for implementation and supported by suggestive clinical or epidemiologic studies or a theoretical rationale (Level of evidence: Very low–High)	
Unresolved issues	Represents an unresolved issue for which evidence is insufficient or no consensus regarding efficacy exists (Level of evidence: Very low–High)	

1. Infection prevention and control program

- 1.1. Each dialysis unit should develop and implement an infection control program in order to prevent infection and reduce the risk of infection; (IB).
- 1.2. Dialysis units or centers should establish a rapid response system for emergencies such as epidemics and national disasters related to infectious diseases; (IB, IC).
- 1.3. The following activities should be carried out according to the rules and policies of each institution; (IB).
 - The planning, implementation and surveillance of infection control measures to protect the health of dialysis staff
 - Infection control education and training for dialysis staff
 - Sterilizing, disinfecting, and cleaning equipment and supplies
 - Environmental control (disinfecting and cleaning)
 - Initiation and maintenance of dialysis, control of the source of blood-borne infections, infection control for vascular access, water treatment, and vaccination
 - Basic protective measures such as hand hygiene, isolation precautions, and aseptic techniques

Operating a healthcare-associated infection surveillance system

To reduce or minimize healthcare-associated infections in the hemodialysis room, the infection control division or committee of each healthcare facility should operate an infection prevention and management program, including an infection risk assessment [1]; (IB). If the healthcare facility does not have an infection control division or committee, the head of the healthcare facility can manage the program, and the employees in the hemodialysis room should follow the rules and procedures recommended by the program. The infection prevention and management program should include infection surveillance and monitoring processes, strategy development to reduce or minimize the risk of infection, and evaluation and feedback processes for redesigning and implementing the revised program [1–3]; (IB). The dialy-

sis room should be monitored for a certain period so that infection control issues can be identified in terms of the units, infection sites, microorganisms, etc. Ongoing surveillance activities may identify health-associated events or problems about which recommendations and action plans can be developed to minimize infection transmission and reduce future incidents [1,2,4]; (IB). The results of these activities should be reported to the leadership and shared among the clinical staff [1–3]; (IB). Surveillance and monitoring activities should be followed by adequate employee education and the development of corrective actions [1–3]; (IB). The problems identified by surveillance activities may be addressed in the quality improvement process [1–3]; (IB).

Management of outbreaks

An outbreak is a sudden increase in the occurrence of an infection or colonization at a particular time and place, or the sudden occurrence of an unusual disease. The head of the dialysis room should identify the occurrence of outbreaks or epidemics of infectious diseases [1–3]; (IB). The occurrence of an outbreak should be reported to the infection control division or committee immediately. The infection control division or committee should closely examine the outbreak and provide the appropriate infection control measures to the dialysis room staff. Employees in the dialysis room should perform the infection control and prevention measures in cooperation with the infection control division or committee. If the healthcare facility does not have an infection control division or committee, the director of the healthcare facility may assume the same role. A rapid response system should be established for emergency situations such as epidemics and national disasters related to infectious diseases [5]; (IB, IC).

2. Hand hygiene

- 2.1. Dialysis staff should perform hand hygiene in an appropriate manner when hand hygiene is required during dialysis.
- 2.2. The situations where hand hygiene is required are as follows; (IB):
 - 2.2.1. Before touching a patient (e.g., measurement of vital signs, evaluation of vascular access)

- 2.2.2. Before performing a clean or aseptic procedure
 - Before intervention (e.g., dialysis preparation)
 - Before drug administration
 - Before management of an area with broken skin integrity (e.g., catheter dressing)
 - Before an invasive procedure (e.g., cannulation of vascular access or vein puncture)
- 2.2.3. After body fluid exposure risk (e.g., hemostasis after dialysis therapy)
- 2.2.4. After touching a patient (e.g., measurement of vital signs)
- 2.2.5. After touching a patient's surroundings (e.g., finishing dialysis therapy)
- 2.3. Hemodialysis patients, as well as their families and visitors, should also perform hand hygiene in an appropriate manner when entering the dialysis room.

ready, the employee should perform hand hygiene before checking the vital signs of the patient. Then, the employee should perform hand hygiene and put on gloves before preparing the skin for cannulation. After performing the cannulation and connecting a hemodialysis line to the machine, the employee should put on gloves and perform hand hygiene. After cleaning the hemodialysis set and disposing the waste materials, the employee should perform hand hygiene. Throughout the hemodialysis process, the employee should perform additional hand hygiene before and after touching the patient or after touching equipment or items near the patient. After the hemodialysis treatment, the employee should perform hand hygiene before checking the vital signs of the patient. Hand hygiene should be performed before and after needle removal. Lastly, the employee should perform hand hygiene after removing the lines and cleaning up the hemodialysis area.

Background

'Hand hygiene' is a comprehensive term that includes hand washing and hand antisepsis. 'Hand washing' refers to the washing of hands with soap and water, while 'hand antisepsis' refers to the application of hand sanitizers for hand rubbing or hand washing to reduce microbes on the hands or inhibit microbial growth. Hand antisepsis can be performed in the absence of visible contamination, while hand washing should be performed when the hands are visibly soiled with contaminants. Wearing gloves cannot replace hand hygiene. Not only hemodialysis patients, but also their families and visitors, should perform hand hygiene in an appropriate manner before entering the hemodialysis room.

Hand hygiene in the hemodialysis process

For all vascular accesses, aseptic techniques should be used for cannulation and catheter manipulation. The following is an example of how and when to perform hand hygiene during the hemodialysis process. When there is a patient with a mature arteriovenous fistula for hemodialysis, the employee should locate, inspect, and palpate the needle cannulation site after performing appropriate hand hygiene. After the inspection, hand hygiene should be performed before the preparation of the hemodialysis set and priming. When the hemodialysis machine is

3. Isolation strategies

- 3.1. Quarantine measures may be taken if necessary to prevent the transmission of infections from patients with suspected or confirmed infections.
- 3.2. Patients with acute respiratory infection symptoms should be instructed to wear surgical masks and follow proper cough etiquette when entering the dialysis room.
- 3.3. Standard precautions should be applied when dealing with all suspected or confirmed infections in patients; (IA). Depending on the mode of transmission (contact, droplet, and/or airborne), additional precautions should be taken.
- 3.4. A patient with an infectious disease for which contact or droplet precautions are required should either receive dialysis therapy in a single-occupancy isolation room, by the cohort isolation method, or be last in the order after others have completed their dialysis therapy.
- 3.5. A patient with an infectious disease for which airborne precautions are required can receive dialysis in either a negative-pressure room or a single-occupancy isolation room.
- 3.6. Inter-hospital and intra-hospital transfer of patients who require isolation care should be limited to absolutely necessary cases; (II).

Background

Isolation is performed to prevent infection or the transmission of microorganisms from confirmed or suspected cases of infection to other patients or staff. To minimize the exposure to and transmission of infections in hemodialysis units, each unit should implement infection prevention and control measures systematically based on standard, contact, droplet, or aerosol precautions. A standard precaution is a practice designed to prevent the transmission of an infection by contact with body fluids. The concept of a standard precaution is based on the principle that any blood, body fluid, secretion, or excretion from any patient may contain transmissible infectious agents; (IA). Standard precautions involve the use of personal protective equipment (PPE) such as masks, face shields, gowns, and gloves [6]; (IB). In hemodialysis settings, the risk of exposure to blood and blood-borne pathogens is increased because the bloodstream is accessed during the dialysis session; therefore, more rigorous steps to protect personnel and patients from infection sources should be followed.

Basic principles of isolation according to the mode of transmission of the pathogen

The staff in the dialysis room or infection control division should consult with patients with confirmed infectious diseases to determine whether they can postpone hemodialysis during the quarantine period. If dialysis is inevitably required during the isolation period, then contact, droplet, or airborne precautions should be observed according to the mode of transmission of the pathogen. The detailed isolation methods and necessary items are listed in Table 2. The duration of isolation should be based on the infection control policies of the relevant healthcare facility.

Table 2. Isolation method and items according to the mode of transmission

Component	Standard precaution should be followed in all cases			
	Contact precaution	Contact precaution +	Droplet precaution	Airborne precaution
Patient placement	Dialysis therapy in a single-patient room or cohort isolation or at the last sequence		Dialysis therapy in a negative pressure room or a single-patient room	
Isolation sign	○	○	○	○
Hand hygiene	Hand asepsis with an alcohol-based hand rub or hand washing with antimicrobial soap and water	Hand washing with antimicrobial or nonantimicrobial soap and water	Hand asepsis with an alcohol-based hand rub or hand washing with antimicrobial soap and water	Hand asepsis with an alcohol-based hand rub or hand washing with antimicrobial soap and water
Separate medical equipment (blood pressure cuff or stethoscope, etc.)	○	○	×	×
PPE for staffs				
Gloves	○	○	×	×
Gown	○	○	×	×
Surgical masks	×	×	○	×
N95 mask	×	×	×	○
PPE for patient	Hand hygiene	Hand hygiene	Hand hygiene Surgical masks	Hand hygiene N95 masks
Special container for biomedical wastes	○	○	○	○

PPE, personal protective equipment.

4. Infection prevention during the dialysis procedure

- 4.1. The catheter exit site or cannulation site of an arteriovenous fistula or arteriovenous graft should be examined for the absence of infection before the bloodstream is accessed at each hemodialysis session; (IB).
- 4.2. Hand hygiene and aseptic techniques should be followed throughout all dialysis procedures; (IB).
- 4.3. The use of common supplies between patients is prohibited.
- 4.4. Injections should be prepared in a room or area separate from the patient treatment area and administered to patients after their identities have been checked; (IB).
- 4.5. For the preparation of multi-dose injections (e.g., heparin), each dose should be weighed in a separate syringe for each patient in the preparation room, and multi-dose injection vials should not be taken to the patient treatment area.

Infection control measures during the dialysis procedure

Standard precautions should be followed for all patients receiving hemodialysis [6]; (IA). Before cannulation or catheter manipulation, the employee should closely examine the vascular access site for signs of infection [7]; (IB). The employee should perform adequate hand hygiene and put on gloves before gaining vascular access. If a patient has an arteriovenous fistula or graft, the skin should be adequately prepared with 2% chlorhexidine/70% alcohol or 10% povidone iodine at the site of puncture [7]. Gloves should be changed if contaminated at any time during the cannulation procedure [7]. If a patient has a dialysis catheter, the catheter exit site should be examined for proper positioning and the absence of infection before the catheter is opened and accessed. If possible, it is recommended that two employees begin dialysis together [7]. While one employee manipulates the catheter, the other can manipulate the dialysis machine to prevent bloodstream infection. After the cap is removed, the hub should be wiped with 2% chlorhexidine/70% alcohol or 10% povidone iodine. The catheter hub should be connected immediately to limit exposure to air [7]. The lumen of the hemodialysis catheter should always be kept aseptic. Fluid infusion through the hemo-

dialysis catheter is strictly prohibited.

Catheter manipulation should be kept to an absolute minimum during dialysis therapy. The items used for the dialysis procedure should be used for a single patient and discarded after use [8]. If the items are not for a single use, the items should be disinfected before being used on other patients. A common supply cart or medication tray should not be shared between patients. Throughout all dialysis procedures, standard precautions and aseptic techniques should be followed [9]; (IB).

Principles of using multi-dose injections

Injections should be prepared in a clean area separate from the patient treatment area [10]; (IB). Single-dose vials should be used for parenteral additives or medications whenever possible [10]; (IB). For the preparation of multi-dose injections such as heparin sodium, each dose should be weighed in a separate syringe for each patient in a clean area. The multi-dose vial itself should not be taken to the patient treatment area. After use, the vial should be stored in a refrigerator at 2°C to 8°C until subsequent use. The rubber diaphragm should be disinfected before every use [6,11,12]; (IB).

5. Control of the source of blood-borne infections

- 5.1. All hemodialysis patients should undergo routine screening for hepatitis B and hepatitis C infections; (IB).
- 5.2. Patients at risk for hepatitis B infection should be vaccinated against hepatitis B virus (HBV).
- 5.3. Patients who are hepatitis B surface antigen (HBsAg) positive should be dialyzed with separate machines, equipment, instruments, and supplies; (IB).
- 5.4. Patients with hepatitis C and human immunodeficiency virus (HIV) infections are not recommended to be isolated from other patients or dialyzed separately on dedicated machines if standard precautions are followed; (IB).

Background

This chapter is dedicated to preventing infections through the blood in hemodialysis patients, and provid-

ing the best medical care by reducing the risk of blood-borne infections among employees working in the hemodialysis room. All hemodialysis patients should undergo routine testing for hepatitis B and hepatitis C (Table 3). Periodic screenings for hepatitis D virus and HIV infections are not recommended; (II).

HBV isolation and precautions

Standard precautions should be followed by employees dealing with HBsAg-positive dialysis patients [8,13]; (IB). Dialysis should be performed in a separate space on a separate hemodialysis machine, and surfaces should be disinfected after dialysis [8,13]; (IB). Employees who care

for HBsAg-positive patients should not nurse patients who are at risk for infection (anti-HBs negative) at the same time [8,13]; (IB). The dialysis membranes used by HBsAg-positive patients may not be reused because they may infect employees.

If a person is exposed to blood or body fluids from a suspected HBV-infected patient, a blood sample should be taken from the suspected infection case to determine the HBsAg status of the suspected HBV-infected patient; (IB). The subsequent measures may differ according to the HBsAg status of the suspected infection case, the vaccination history of the exposed person, and the anti-HBs status of the exposed person.

HCV and HIV precautions

Patients with negative anti-HCV results should undergo anti-HCV testing every 6 months (Fig. 1) [8,13,14]; (IB). Regular HIV testing is not recommended for infection control purposes [8,13]; (II). The transmission of infection can be prevented by adherence to standard precautions and infection prevention measures. Patients with hepatitis C and HIV infections are not recommended to be isolated from other patients or dialyzed separately on dedicated machines if standard precautions are followed; (IB).

Table 3. Schedule for routine testing for HBV and HCV infections

Patient status	On admission	Semiannual	Annual
All patients	HBsAg		
	Anti-HBc		
	Anti-HBs		
	Anti-HCV		
Anti-HBs negative (< 10 mIU/mL)		HBsAg	
Anti-HBs positive (≥ 10 mIU/mL)			Anti-HBs
Anti-HBs & anti-HBc positive		No additional HBV testing needed	
Anti-HCV negative		Anti-HCV	

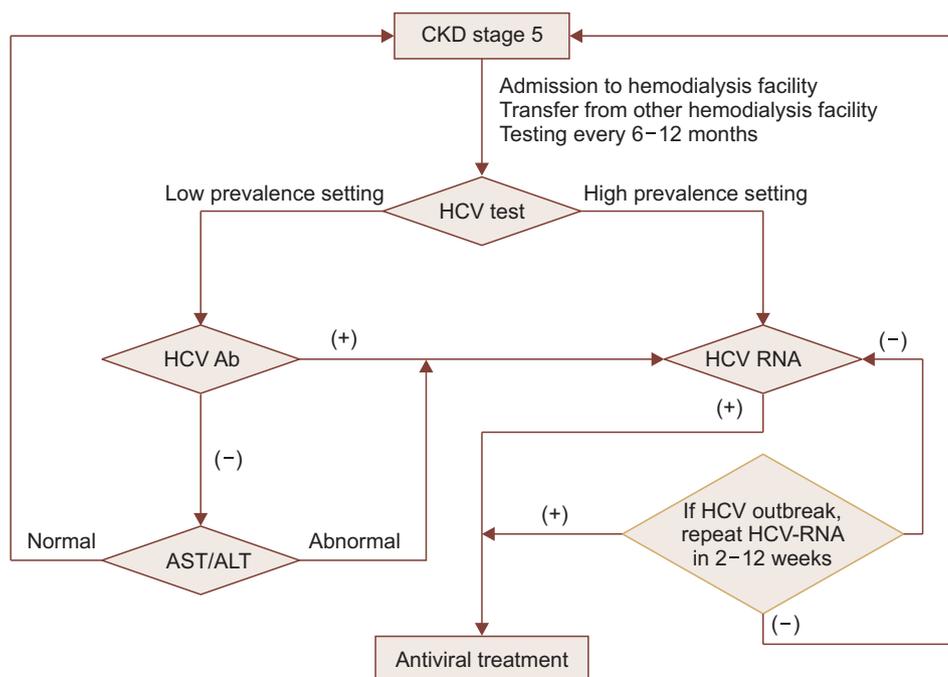


Figure 1. Algorithm for HCV infection in hemodialysis patients.

Ab, antibody; ALT, alanine aminotransferase; AST, aspartate aminotransferase; CKD, chronic kidney disease; HCV, hepatitis C virus.

Adopted from the KDIGO guidelines (Kidney Int Suppl 2008;(109):S1-S99) [14].

6. Infection control for vascular access

- 6.1. Temporary catheters should be kept for a minimum period and removed as soon as possible; (IA).
- 6.2. The catheter exit site and catheter hub should be examined for the absence of infection at each hemodialysis session when a patient uses a catheter for dialysis; (IB).
- 6.3. The employee should wear a mask and sterile gloves when the catheter is being manipulated; (IB).
- 6.4. The vascular access site should be washed with antibacterial soap and water before cannulation when an arteriovenous access is used for dialysis.
- 6.5. The employee should follow aseptic techniques for vascular cannulation; (IB).

Insertion of a hemodialysis catheter

A central venous catheter for dialysis should be used for a minimum period until a permanent vascular access such as an arteriovenous fistula or arteriovenous graft is available for use [7,10,13,15]; (IA). If the catheter is needed for more than 1 or 2 weeks for dialysis, a tunneled catheter with a cuff should be inserted [7,10,13,15]; (IB). Maximum barrier precaution with a surgical mask, a sterilized gown, sterilized gloves, a cap, and a whole-body drape should be used for catheter insertion [7,10,13,15]; (IB). The catheter insertion site should be disinfected with a 0.5% to 2% chlorhexidine/alcohol solution [7,10,13]; (IB). For the prevention of catheter-related complications, the internal jugular vein is the preferred site for catheter insertion, while the femoral and subclavian veins should be avoided for insertion, if possible [13]; (II). Ultrasound equipment can be used to identify a vein that is suitable for the insertion of a hemodialysis catheter to reduce the number of attempts and complications. The procedure should be performed by well-trained medical staff [16]; (II). Systemic antibiotics are not recommended for use before catheter insertion to prevent bacterial colonization or catheter-related bloodstream infections [16]; (IB). The hemodialysis catheter should be removed if it is no longer needed for dialysis [16]; (IA).

Exit site care when a hemodialysis catheter is used

The catheter exit site should be cleaned at the time of the dressing change with 2% chlorhexidine/70% alcohol or a 10% povidone-iodine solution [7,9]. The dressing should be changed at each hemodialysis session if it is a gauze-type dressing, or every 7 days if it is a transparent dressing, in addition to whenever the dressing is wet or soiled [7,9,10,13]; (IB).

7. Water treatment

- 7.1. The use of ultrapure water is considered vital during hemodialysis, especially in the case of high-flux dialysis or hemodiafiltration (HDF).
- 7.2. The water produced for dialysis should be tested regularly for bacteriological and chemical contaminants. When the results of assays exceed acceptable levels, corrective measures should be taken promptly to reduce the levels of bacteria/chemicals.
- 7.3. Bacteriological assays of water should initially be performed weekly to validate the adequacy of the dialysis machine disinfection process, and should then be performed monthly once the process has been established.
- 7.4. Chemical tests of water should be performed annually.

Depending on the degree of purification, the water used for dialysis can be categorized as standard pure water or ultrapure water. The use of ultrapure water is considered vital during hemodialysis, especially in the case of high-flux dialysis or HDF [17,18]. Water should be purified through pre-processing (microfilter, softener, carbon filter), reverse osmosis (RO), deionizing, and post-processing procedures [17]. The water produced for dialysis should be tested regularly for bacteriological and chemical contaminants. When the results of assays exceed acceptable levels, corrective measures should be taken promptly to reduce the levels of bacteria/chemicals [17,18]. Bacteriological assays of water should initially be performed weekly to validate the adequacy of the dialysis machine disinfection process, and should then be performed monthly once the process has been established [13,16,19]. Endotoxin assays should be performed every

3 months, or more frequently if the water treatment system is being tested for adequacy or if HDF is being performed. Chemical assays should be performed annually for dialysis water. Samples for the assay should be taken from the RO port before dialysis, and from the sampling port of the hemodialysis machine during or after dialysis [17,18].

8. Waste management

- 8.1. The materials used in the hemodialysis process, such as dialysis membranes, lines, or needles, should be treated as biomedical waste, placed in a special container, and handled by a waste disposal contractor.
- 8.2. Used hemodialysis fluid is not considered biomedical waste since it does not make direct contact with blood.

‘Medical wastes’ are wastes discharged from medical institutions, wastes that may cause harm to the human body, and wastes such as human tissues that are considered to require special care in terms of health and environmental protection. Medical wastes can be classified as ‘biomedical wastes’ or ‘general medical wastes,’ and biomedical wastes should be considered potentially harmful or infectious. The materials used in the hemodialysis process, such as dialysis membranes, lines, or needles, should be treated as biomedical wastes, placed in a special container, and handled by a waste disposal contractor. However, used hemodialysis fluid is not considered biomedical waste since it does not make direct contact with blood.

9. Sterilizing, disinfecting, and cleaning

- 9.1. The items and equipment used in the dialysis process should be cleaned, disinfected, and sterilized according to their characteristics.
- 9.2. The water treatment and distribution system should be regularly disinfected according to the manufacturer’s manual.

The items and equipment used in the dialysis process should be cleaned, disinfected, and sterilized according

to their characteristics. Sterilized items should be stored separately from contaminated items, and all employees should store and use sterile items properly before their expiration dates. Disposable items should be placed in medical waste containers after being used in the hemodialysis unit. Non-disposable items should be cleaned or disinfected in a separate cleaning zone in the hemodialysis unit. If the items need to be sterilized, they should be sent to the sterile processing department of the health-care facility. Employees should wear appropriate PPE such as waterproof aprons, gloves, safety goggles, and masks when cleaning or disinfecting items. The water treatment and distribution system should be disinfected regularly according to the manufacturer’s manual.

10. Laundry care

- 10.1. The laundry should be collected and classified as contaminated laundry or other laundry.
- 10.2. The transmission of infectious agents from the source should be prevented by adherence to infection control measures when laundry cloths are handled.

The laundry should be collected and classified as contaminated laundry or other laundry. ‘Contaminated laundry’ refers to laundry that has been used by an infected person or has possibly been contaminated with body fluids (blood, pus, etc.) or infectious materials. Contaminated laundry should be collected in a separate laundry basket. The area for laundry collection should be designated as separate from the open and clean space. Clean linens and cloths should be delivered on a separate linen cart and be stored in a clean and dry place before use.

11. Environmental control

- 11.1. The guidelines for environmental infection control in each healthcare facility should be followed so that all areas occupied by patients, employees, and visitors are kept clean and safe.
- 11.2. The hemodialysis machine should be rinsed after each dialysis session, and the interior of the dialysis machine should be disinfected at the end of the day; (IB).

- 11.3. The waste treatment area (cleaning room and sewage room) should be separate from the patient treatment area, storage room, and clean area.

Principles for cleaning and disinfecting hemodialysis units

The guidelines for environmental infection control in each healthcare facility should be followed so that all areas occupied by patients, employees, and visitors are kept clean and safe. All cleaning should be done in a manner that minimizes dust generation [20–22]; (IB). A high-efficiency particulate air filter should be used with the vacuum cleaner [20–22]; (IB). The mop should not be shaken after use, because fungal spores may be spread. Cleaning and disinfecting should be done from a cleaner area to a dirtier area, and from a higher area to a lower area. Areas that people touch frequently should be cleaned more frequently. A disinfectant should not be sprayed over the patient treatment area. Gloves and other protective equipment (gowns, masks, safety goggles) should be worn when there is a possibility of exposure to harmful substances, blood, or body fluids from patients [20,22,23]; (IB).

The hemodialysis machine should be rinsed after each dialysis session, and the interior of the dialysis machine should be disinfected at the end of the day [20–22]; (IB). The surface of the hemodialyzer should be disinfected after each dialysis session with an ammonium compound or sodium hypochlorite at a 1:100 dilution. The linens (sheets and pillowcases) should be changed after each dialysis session. The floor of the hemodialysis unit should be cleaned every day, or more frequently if it has been soiled or contaminated [20–22]; (II). The waste treatment area (cleaning room and sewage room) should be separate from the patient treatment area, storage room and clean area.

12. Vaccination

- 12.1. Hepatitis B, pneumococcal, and influenza vaccinations are recommended for dialysis patients.
 12.2. Shingles vaccination is recommended for dialysis patients over 60 years of age.
 12.3. Hepatitis A vaccination is recommended for dialysis patients born after 1961.

Patients and staff without anti-HBs antibodies should be vaccinated as soon as possible, because they are always exposed to the risk of cross-infection through blood products or dialysis equipment. Because dialysis patients have low antibody positivity after vaccination, higher doses (40 µg in adults) than the regular dose (20 µg) should be injected intramuscularly into the deltoid muscle three times, at 0, 1, and 6 months [8,24,25]. ‘Non-responders’ with anti-HBs levels < 10 mIU/mL after three injections should be re-vaccinated. ‘Responders’ to HBV vaccination should have their anti-HBs antibody titers checked annually, and if the titer falls below 10 mIU/mL, a booster HBV vaccination should be administered. Pneumococcal and influenza vaccinations are also recommended for dialysis patients. In addition, patients over 60 years of age should be vaccinated against shingles unless otherwise indicated. If a patient was born before 1967 or was not inoculated with a tetanus-related vaccine in the last 10 years, the first dose of the tetanus, diphtheria, and pertussis vaccine should be administered, and the tetanus-diphtheria vaccine should be administered every 10 years thereafter. Hepatitis A vaccination is recommended for dialysis patients born after 1961.

Discussion

Patients with ESRD are vulnerable to infectious diseases due to multiple comorbidities and reduced immune function. Due to the passive nature of dialysis therapy, hemodialysis patients can easily spread diseases through the narrow space between their beds. Therefore, appropriate infection control measures are very important to prevent the transmission of diseases in dialysis facilities.

Although these guidelines were created as recommendations for infection control in hemodialysis facilities based on a systematic literature review of as many articles and guidelines as possible, the research findings that could be used as evidence were very limited. We tried to overcome this limitation by consulting with experts in this field for internal and external review. However, it will be necessary to revise and update these guidelines based on future research and evidence. We hope that these guidelines will contribute to improved quality control and infection prevention in hemodialysis facilities.

Conflicts of interest

All authors have no conflicts of interest to declare.

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