Infection Control Guidelines on Nephrology Services in Hong Kong 2023

4th Edition (Version 4.1)

Jointly prepared by
Infection Control Branch, Centre for Health Protection, Department of Health
and
Central Renal Committee, Hospital Authority

衞生防護中心乃衞生署轄下執行疾病預防及控制的專業架構
The Centre for Health Protection is a professional arm of the Department of Health for disease prevention and control

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FOREWORD

While working or staying in nephrology service unit, one may be exposed to various pathogens. Effective infection control strategies are therefore essential to provide a safe environment for both patients and staff. [1-18]

This guideline is produced by a working group established by the Infection Control Branch, Centre for Health Protection and the Central Renal Committee, Hospital Authority. The membership of the working group for the fourth edition includes specialists in nephrology, hepatology and microbiology, the Chief Infection Control Officer in Hospital Authority, representatives from the Hong Kong Kidney Foundation, the Hong Kong Association of Renal Nurses, the Hong Kong Infection Control Nurses' Association and the Electrical and Mechanical Services Department of Hong Kong Government.

The guideline intends to provide practical infection control information in both clinical and home dialysis settings. It outlines new evidence and approaches in delivering infection control practices, and highlights the principles set out in various local and international advisory and guidance documents. There are eleven sections in the guideline, covering pathogens commonly encountered in the nephrology services, immunisation, quality management as well as practical control measures in clinical, home and occupational settings. Healthcare workers in nephrology service units should have a thorough understanding of the guideline and be able to provide appropriate training for other relevant staff, if indicated.

This guideline, however, is not meant to be exhaustive, in view of continuously emerging biological hazards and control measures. Updated information can be obtained from the Infection Control Branch, Centre for Health Protection of the Department of Health and the Central Renal Committee, Hospital Authority.

We thank the members of the working group who have contributed so much of their knowledge, expertise and time to produce this guideline.

1. VIRAL HAZARDS

In renal dialysis units, blood-borne viruses (BBV) are an infectious hazard and may be transmitted by blood transfusion, parenteral inoculation or acquired during dialysis procedures, mainly as a result of lapses in infection control practices. [1] Documented reports of outbreaks in renal dialysis units include hepatitis B virus (HBV) [19-31], hepatitis C virus (HCV) [16, 32-34], and human immunodeficiency virus (HIV) [35, 36]. Previous study in 2011 indicated that 9.3% and 1.9% of patients in our renal units had HBV and HCV respectively. [37] More recent data from the Hong Kong Renal Registry in 2023 showed that the prevalence of HBV and HCV infection in our renal units is 8.5% and 0.5% respectively. In order to reduce the risk of infection, adherence to infection control precautions should be carefully addressed.

1.1 Potential Risks for Transmitting BBV in Dialysis Units

The most common causes known to be responsible for BBV transmission in dialysis units are as follows:

1.1.1 Sharing of multi-dose vials of drugs. [16, 19-23, 25, 31, 32, 38]

1.1.2 Caring patient with contaminated hands or gloves as the healthcare workers have not properly performed hand hygiene or changed their gloves. [19, 26, 31, 33, 34, 38]

1.1.3 Failing to clean and disinfect dialysis machines, equipment, supplies and environmental surfaces properly when they are shared between patients. [21, 31, 32, 35, 36, 38]

1.1.4 Failing to prevent contamination of parenteral medications which are prepared on common mobile medication carts at patients' dialysis stations. [31, 32, 38]

1.1.5 Failing to identify and isolate patients who are positive for the HBV. [1, 19-21, 26, 27, 31, 38]

1.1.6 No dedicated haemodialysis machines, equipment, supplies or staff for the Hepatitis B surface antigen (HBsAg) positive patients. [19-21, 26, 29-31, 38]

1.1.7 Failing to vaccinate susceptible patients against HBV. [19, 20, 24, 31, 38, 39]

1.2 Prevention of BBV Transmission in Dialysis Units

Based on the above experiences, the following guidelines should be strictly observed in addition to those stipulated in section 7 of this document, so as to prevent any potential risks which may arise in haemodialysis, especially for patients with hepatitis B:

1.2.1 Isolate HBsAg positive or HBV Deoxyribonucleic acid (DNA) positive patients in a separate room or cubicle. [31, 38, 40]

1.2.2 Dedicate staff for HBsAg positive or HBV DNA positive patients in the same dialysis session, if possible. [31]

1.2.3 Dedicate dialysis machines, equipment, instruments, medications, maintenance tools and supplies for HBsAg positive or HBV DNA positive patients. [31, 40, 41]

1.2.4 Ideally, dialysis equipment should be designated and segregated according to HCV and HIV status especially in areas of high prevalence, but this may not be always feasible, and thorough disinfection and cleaning of equipment according to standard procedures, with strict adherence to standard precautions and infection control measures, is obligatory prior to their use on other patients. [42]

1.2.5 Do not reuse dialysers. [31]

1.2.6 Vaccinate all susceptible patients against HBV. [31]

1.3 Prevention of Respiratory Virus Transmission in Dialysis Units

When patient presents with respiratory symptoms, the following guidelines should be strictly observed in addition to those stipulated in section 7 of this document.

1.3.1 Apply standard and transmission-based precautions for the patient.

1.3.2 Place infected patient(s) in well-ventilated designated room / cubicle / area separated from others (e.g. with partition).

1.3.3 Wear well-fitted surgical mask for staff and patients.

1.3.4 Cover mouth and nose when coughing or sneezing and perform hand hygiene afterwards. [43]

1.3.5 Use tissue papers to contain respiratory secretions and dispose them in a rubbish bin with lid. [43]

1.3.6 Take annual seasonal influenza vaccination to minimise the potential risk of patient exposure. [43]

2. BACTERIAL AND FUNGAL HAZARDS

2.1 Prevention and Control of Multi-Drug Resistant Organisms

Multi-drug resistant organisms (MDROs) have emerged as important pathogens of nosocomial infections among hospitalised patients, including those with chronic renal failure. The impact of MDROs on renal patients was evident in increasingly common reports of methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant *enterococci* (VRE) in this group of patients, as well as ongoing outbreaks of MDROs in haemodialysis centres. [44] The morbidity and mortality of renal patient with invasive MDRO infections are significantly higher than the other patient groups. [21, 44, 45] Risk factors for the selection or acquisition of MDROs in renal patients include the use of vancomycin or other broad-spectrum antibiotics, frequent visits to healthcare settings, indwelling catheters and weakened immune status. [31, 45, 46] Furthermore, the prolonged survival of MDROs in the environment facilitates nosocomial transmission by direct patient-to-patient contact or indirectly from healthcare workers to patients via contaminated environmental surfaces and patient care equipment. [15, 31]

2.1.1 Prudent use of antibiotics is of paramount importance in the prevention of MDROs. Please refer to the IMPACT guidelines on antibiotic use, which can be accessed at the following link:

http://www.chp.gov.hk/files/pdf/reducing_bacterial_resistance_with_impact.pdf

2.1.2 Contact precautions, in addition to the Infection Control Practices in Renal Units (please refer to section 7), should be applied in order to prevent and control the transmission of MDROs in dialysis units as follows:

a. Physical isolation

- Patients with MDROs (e.g. VRE, Carbapenemase-Producing *Enterobacteriaceae* (CPE), Carbapenem-Resistant *Acinetobacter* (CRA) / Multi-Drug Resistant *Acinetobacter* (MDRA), Multi-Drug Resistant *Pseudomonas aeruginosa* (MRPA), MRSA / vancomycin-intermediate *Staphylococcus aureus* (VISA) / vancomycin-resistant *Staphylococcus aureus* (VRSA), *Candida auris*) should preferably be isolated in a single room. [47-50]

- If the above is not feasible, cohort patients with the same MDRO in the same room or cubicle. [47-49]

- A corner bed is the third choice. [47]

- Please refer to 7.1 for requirements on facilities.

b. Wear gown and gloves when direct contact with patients or their immediate environment / equipment. [50]

c. Perform hand hygiene as indicated (please refer to section 7.2).

d. Equipment and instruments

- Equipment in the room / area should be kept to an absolute minimum. [47-49]

- Dedicate patient-care items, such as stethoscopes, blood pressure cuffs, bedpans and thermometers to the patients in isolation. [47-49]

- Ensure that medical equipment (including HD machines) is subjected to appropriate cleaning and disinfection / sterilisation procedures before they are being placed in the clean store or used for other patients.

- Patient charts and records should be kept away from the area to avoid contamination.

- Bedpans, commodes, urinals and washbowls should be cleaned and disinfected immediately after use.

e. Wound management

- All wounds should be covered with dressings at all times. [47-49]

f. Avoid transferring colonised / infected patients within or between facilities as far as practical. If transfer is necessary, inform the receiving unit in advance. [47-49]

g. Terminal disinfection

- Ensure adequate cleaning and terminal disinfection of the isolation room after the patient's discharge, paying particular attention to frequently touched surfaces such as bedrails, dialysis chairs, charts, doorknobs, taps, curtains, and bedside commodes. Environmental disinfection using 1 part of household bleach (5.25% sodium hypochlorite solution) in 49 parts of water is recommended. [47-49, 51]

- Discard all dedicated single-use items.

h. Alert system

- Post signage of contact precautions at the entrance of the isolation room, the patient's dialysis station and kardex.

- Electronic tagging of colonised or infected patients should be done to their computer records. [47-49]

2.1.3 Provide appropriate training on infection control to medical and cleaning staff, and educate patients and their relatives on contact precautions and personal hygiene. [47-49]

2.1.4 Routine surveillance for common MDROs (e.g. MRSA) is encouraged.

2.1.5 Before elective surgical procedures for haemodialysis patients, including the insertion of haemodialysis (HD) catheters per se, conduct MRSA screening and decolonisation with mupirocin to reduce postoperative infection risk. [4, 52]

2.1.6 Consider decolonisation therapy for epidemiologically linked cases during outbreaks. [49]

2.2 Prevention and Control of Tuberculosis

Tuberculosis (TB) is a common infectious disease in Hong Kong. The number of notification is in a decreasing trend, but there are still around 3000 to 6000 notifications per year in the past two decades. [53] Pulmonary TB is highly infectious via airborne transmission, although the risk of transmission is relatively low for TB of extra-pulmonary origin. Patients infected with HIV are at particularly high risk of TB infections, leading to a lethal form of clinical disease. In recent years, the emergence of multi-drug resistant TB (MDR-TB) and extensively drug-resistant TB (XDR-TB) has been a threat among patients with HIV, causing significantly higher mortality. However, MDR-TB and XDR-TB are not known to be more contagious than their susceptible counterparts. A high index of clinical suspicion, prompt isolation and early treatment of infectious cases are warranted. [54]

Airborne precautions should be applied to prevent and control pulmonary TB in the dialysis unit as follows:

2.2.1 Dialyse patients with suspected or known open TB in an Airborne Infection Isolation Room (AIIR)*.

Remarks:
*The air exhausted from the room is not re-circulated. If recirculation of air is necessary, it should pass through a High Efficiency Particulate Air (HEPA) filter. [4] Regular technical maintenance of isolation facilities is essential. [54]

2.2.2 Regular checking of air exchange with the recommended exchange rate should be conducted.

2.2.3 No particular ventilation facilities are required for TB patients who fulfill the following criteria:

a. In general, patients with active infectious pulmonary TB are to be placed in an appropriate TB isolation room / ward for at least 2 weeks after commencement of effective anti-TB therapy. [54]

b. For laboratory confirmed TB patients, in absence of rifampicin resistance, having received and tolerated standard multi-drug anti-TB treatment for at least 14 days with demonstrated clinical improvement. [54]

c. At least 3 negative smears for acid-fast bacillus on separate occasions (each collected at 8-24 hour intervals, preferably with at least one specimen being an early morning specimen) ** over at least a 14-day period if dialysed in the same room or cubicle with HIV / other immunocompromised patients. [54]

**As the sputum collection is subject to much variation and patient's condition can also change, the overall clinical progress should be taken into account in the interpretation of sputum test results.

d. Three negative smears at weekly intervals and ideally have a negative culture for patients with known / suspected MDR-TB. [54] For those whose symptoms have improved and who are unable to produce sputum, discharge decisions should be taken by the multidisciplinary team.

2.2.4 Healthcare workers should wear N95 respirators when caring for patients with, or suspected of, having TB. [9]

2.2.5 Wear gloves when handling potentially infectious materials, e.g. sputum. [54]

2.2.6 Infectious TB patients (especially those with uncontrolled cough) utilizing common investigation facilities outside the TB isolation ward / room (e.g. radiology department or electro-diagnostic department) should wear well-fitted surgical masks to reduce the production of airborne droplets. [9, 54]

2.2.7 Health education should be provided for patients, including the need to observe personal hygiene. [4]

3. PREVENTION OF DIALYSIS-ASSOCIATED RISKS

3.1 Prevention of Haemodialysis-Associated Infections

Vascular access is required to enable the drawing of blood from and its return to the patient during the haemodialysis process. To maximise the amount of blood cleansed during haemodialysis treatments, the vascular access should allow continuous, high volumes of blood flow. [55]

A vascular access consists of an arteriovenous fistula (AVF), an auto arteriovenous graft, a synthetic arteriovenous graft (AVG), or a dialysis catheter, either tunnelled cuffed or uncuffed.

An AVF is regarded as the vascular access of choice for haemodialysis because of its superior patency and lower complication rates. [55-59] The rate of bloodstream infections per 100 patient-months was 0.64 (0.26 for AVF, 0.39 for AVG, and 2.16 for central venous catheter (CVC)) in 2014 data submitted to National Healthcare Safety Network (NHSN) Dialysis Event Surveillance, Centers for Disease Control and Prevention (CDC). [60] The rate decreased for every vascular access type from 2014 to 2019 (0.17 for AVF, 0.32 for AVG, and 1.21 for CVC). [61]

The incidence of catheter-related bloodstream infections varies considerably by type of vascular access, frequency of vascular access manipulation and patient-related factors. [3] It is usually caused by contamination of the insertion site or the catheter hub. [7]

3.1.1 Selection of vascular access and catheter

a. For long term vascular access, the best option is an AVF; while an AVG is preferred over CVCs. [2, 3, 62]

b. Uncuffed femoral HD catheters should preferably be left in place for no longer than 7 days. [7, 63] The uncuffed catheter serves as a temporary access, [3, 55, 64, 65] unless it is the only feasible option of the individual. [62]

c. Tunnelled cuffed HD catheters are preferable to uncuffed HD catheters if the catheters are expected to stay in place for more than 3 weeks. [3]

d. Internal jugular vein is the preferred insertion site. [42]

e. Avoid the subclavian site in haemodialysis patients and patients with advanced kidney disease, to avoid subclavian vein stenosis. [2, 3, 5]

Table 1. Characteristic of vascular access for haemodialysis [3, 4, 63]

Type	Method	Pros	Cons
AVF	A surgical anastomosis is created between an artery and a vein to create a large vessel for cannulation and flow	Preferred access type Lowest risk of infection and complications	Requires 6 weeks to 4 months of maturation before AVF can be used
AVG	A synthetic graft is used to create the anastomosis between an artery and vein	Risk of infection comparable to AVF	Requires 3-6 weeks of maturation before AVG can be used Higher rate of complication compared to AVF Life span of graft is shorter than that of AVF
Tunnelled central venous catheter	Cuffed catheters are inserted into large veins through a tunnel under the skin	Immediate access to bloodstream for HD	Much higher rate of infection than AVF or AVG
Non-tunnelled central venous catheter	Catheter is percutaneously placed through the skin directly into a large vein.	Immediate access to bloodstream	Highest risk of infection

3.1.2 Insertion of HD catheter

a. Apply aseptic technique. [3, 5, 66]

b. Perform hand hygiene before and after catheter insertion. [3, 5, 7, 66]

c. Maximal barrier precautions should be implemented. [3, 5, 66]

d. Use 2% chlorhexidine in 70% isopropyl alcohol for site preparation for vascular access insertion. [3, 5, 7, 66]

e. If there is contraindication to chlorhexidine, tincture of iodine, an iodophor (e.g. 10% povidone iodine), or 70% alcohol can be used as alternatives. [3]

f. Use povidone iodine antiseptic ointment or bacitracin / gramicidin / polymyxin B ointment at the haemodialysis catheter exit site after catheter insertion only if this ointment does not interact with the material of the haemodialysis catheter per manufacturer's recommendation. [3, 67]

3.1.3 Care of vascular access and catheter site

a. Manipulation of the dialysis catheter should only be done by trained renal medical and nursing staff. [2]

b. Perform hand hygiene before and after vascular access site manipulation. [3, 7, 55]

c. Appropriate personal protective equipment (PPE) used for vascular access manipulation will provide protection against infections.

d. The catheter should always be kept immobile to minimise pulling and trauma to the exit site in order to prevent infection.

e. Use sterile gauze or sterile transparent dressings with absorbent dressing pad to cover the catheter site. If blood is oozing from the catheter insertion site, a gauze dressing might be preferred. [3, 5]

f. At each haemodialysis treatment, examine the catheter site for signs of infection and change the catheter site dressing. [63]

g. Keep the catheter-site dressing clean and dry; and replace it if the dressing becomes damp, loosened or visibly soiled. [3, 5]

h. Ensure the antiseptics used are compatible with the catheter material in order to avoid damage to the catheter. [3] Always refer to the manufacturer's recommendations.

i. Use povidone iodine antiseptic ointment or bacitracin / gramicidin / polymyxin B ointment at the haemodialysis catheter exit site at the end of each dialysis session only if this ointment does not interact with the material of the haemodialysis catheter per manufacturer's recommendation. [3, 67]

j. US CDC recommends chlorhexidine-impregnated dressings to protect the insertion site of short-term, non-tunneled central venous catheters. [3, 67] They may be considered in units with high infection rates. For long-term hemodialysis catheters in well-healed access sites, it is unclear whether use of a chlorhexidine dressing reduces risk of infectious complications. [67]

k. Routine replacement of intravascular catheters is not necessary if they are functioning and have no evidence of causing local or systemic complications. [3, 5]

l. If the dialysis catheter is not in use, assess the catheter exit site and change the dressing at regular intervals by trained personnel to ensure it is functioning properly and free of infection.

m. If dialysis is no longer required, consider removal of the unnecessary dialysis catheter promptly. [3]

3.2 Prevention of Peritoneal Dialysis related Infections

Ambulatory peritoneal dialysis including continuous ambulatory peritoneal dialysis (CAPD) and automated peritoneal dialysis (APD) can be provided at renal centres. Fresh dialysate is introduced into the peritoneal cavity via a permanently implanted catheter.

Prevention of catheter-related infections is the primary goal of exit-site care and the following precautions should be observed:

3.2.1 A double-cuff peritoneal catheter is preferred. [68]

3.2.2 A downward-directed exit may decrease the risk of catheter-related peritonitis. [68]

3.2.3 Change of catheter dressing should be done by a nurse using aseptic technique until healing is completed. [69]

3.2.4 The exit site should be kept dry until well healed. [69]

3.2.5 Immobilise the catheter to prevent trauma to the exit site and traction on the cuffs. [69]

3.2.6 Recommend that the exit site be cleansed at least twice weekly and every time after a shower or vigorous exercise. [70]

3.2.7 Recommend daily topical application of antibiotic cream or ointment (mupirocin or gentamicin) to the catheter exit site to prevent catheter-related infection. [70]

3.3 Patient Education

3.3.1 Personal hygiene and hand hygiene should be addressed.

3.3.2 Take care of the vascular access / peritoneal dialysis (PD) catheter during daily activities.

a. **Patients with AVF or AVG:**
Observe for proper haemostasis of the cannulation sites and protect the site with sterile dressing pad that are securely taped after haemodialysis treatment. Dressing pad may be removed after 24 hours if no further bleeding or soiling. Patients have to pay attention to protect the vascular access site from injury or infection during daily activities, showering and bathing.

b. **Patients with tunnelled cuffed catheters:**
Bathing is not allowed for the risk as in fresh water activities; showering should only be done with adequate care to protect the catheter and exit site from traction / trauma, to protect the catheter hubs, clamps and exit sites from soaking, accidental cap dislodgement, unclamping and infection.

c. **Patients with temporary uncuffed catheters:**
Bathing or showering of the catheter and the exit site is generally contra-indicated for the high risk of introducing infection to the catheter exit site and catheter dislodgement. Careful sponging with good personal hygiene practice is allowed, paying special attention to prevent untoward events, for example traction / trauma to the catheter, introduction of infection to the catheter exit site, dislodgement of the catheter, damage to the catheter hubs or unclamping of the catheter clamps.

d. **Patients with peritoneal catheters:**
In general showering of the healed exit site may be allowed with the application of gentle cleansing agent. Care must be applied to avoid accidental traction or trauma to the catheter and exit site during daily activities. Proper exit site dressing must be carried out immediately after the showering. [69] Application of safety pins or brooches near a peritoneal dialysis catheter should be avoided as this may lead to accidental puncture of the catheter.

3.3.3 Monitor the condition of the catheter site and report any signs and symptoms of infection.

3.4 Staff Training and Supervision

3.4.1 Provide training to staff working in nephrology services, including infection prevention and control practices, technique for catheter insertion, maintenance on HD and PD catheters, standard operating policies for different procedures. [1-3]

3.4.2 Staff should be supervised and competency assessments are recommended before they are considered competent to practice safely. [2, 3]

3.4.3 Inspect catheter site for signs and symptoms of infection at each dialysis session. Signs of systemic infection should also be monitored for vascular access associated infection. [3]

3.4.4 Staff working in the renal units including medical, nursing and supporting staff should receive training in infection control practices, especially hand hygiene techniques and appropriate use of PPE. [42]

3.4.5 Adherence to infection control practices is ultimately important to prevent catheter site infections, peritonitis and bacteraemia.

4. SEROLOGY SCREENING FOR BBV IN DIALYSIS UNITS

Dialysis patients are at risk of acquiring infections caused by BBV, including HBV, HCV and HIV. Investigations of dialysis-associated outbreaks of hepatitis indicate that transmission most likely occurs because of inadequate infection control practices. [31] Transmission of BBV is preventable, and dialysis units should have an established programme for regular surveillance of BBV infections. In case of doubtful serology results, clinical microbiologists should be consulted. [63] Also, it should be borne in mind that the BBV status of healthcare workers must be kept confidential. [63]

4.1 HBV Status in Patients

(Please refer to Table 2 and 3 and Appendix A)

4.1.1 HBsAg, anti-HBs and antibody to hepatitis B core antigen (anti-HBc) should be tested prior to the first dialysis session as a baseline. [31, 42]

4.1.2 In patients susceptible to HBV infection (HBsAg, and anti-HBs both being negative), HBsAg is to be tested every 6 months for those on haemodialysis, and annually for those on peritoneal dialysis. Susceptible patients should also be considered for vaccination against HBV. [31, 42]

4.1.3 In immune patients due to vaccination (anti-HBs positive, anti-HBc negative), anti-HBs is to be tested annually. [63]

4.1.4 In chronic HBV carriers (HBsAg positive) on haemodialysis, annual testing of HBsAg can be considered to detect the small proportion (0.3%) of patients who undergo spontaneous sero-conversion per year. [63]

4.1.5 Patients with acute hepatitis B should be followed up to determine whether they have developed immunity or have become chronic HBV carriers. [42]

4.2 HBV Status in Staff

4.2.1 The individual healthcare worker should be encouraged to assess their immune status at the time of initial employment.

4.2.2 Staff susceptible to HBV infection (HBsAg and anti-HBs both negative) are recommended to receive HBV vaccination. [42, 71]

4.2.3 All HBsAg-positive healthcare workers have the responsibility to take precautions in order to avoid transmitting the infection to others. [72]

4.3 HCV Status in Patients

(Please refer to Table 2 and 4 and Appendix A)

4.3.1 Anti-HCV and alanine aminotransferase levels (ALT) should be tested prior to the first dialysis session as a baseline, and at least every 6 months for anti-HCV negative haemodialysis patients. [31, 63, 71, 73]

4.3.2 Patients who are anti-HCV negative and immunosuppressed, or have undergone a renal transplant, or are being transferred from a unit where there has been a recent HCV transmission should be tested for HCV ribonucleic acid (RNA). [1]

4.3.3 A positive anti-HCV result indicates one of the following: 1) current HCV infection, 2) past HCV infection that has resolved, or 3) false positivity (despite low chance). If HCV RNA is detected, that indicates current HCV infection. If HCV RNA is not detected, that indicates either past, resolved HCV infection or false anti-HCV positivity, and testing with another anti-HCV assay can be considered. [73]

4.4 HIV Status in Patients

(Please refer to Table 2 and Appendix A)

4.4.1 Anti-HIV should be tested prior to the first dialysis session as a baseline. [42]

4.4.2 The routine testing of HIV infection status is not necessary unless clinically indicated. [1, 31] However, annual testing of HIV infection status may be considered in haemodialysis patients. [42]

4.5 Handling of Newly Identified BBV Infections in Dialysis Units

4.5.1 In the event of a newly identified BBV infection in a dialysis unit, testing for the respective viral infection is recommended in other patients who have a history of sharing the dialysis sessions and / or machines with the index patient(s). [42]

4.5.2 Susceptible patient(s) at risk of contracting HBV from a newly infected individual should be given a booster dose of vaccine and be monitored for any sero-conversion to become HBsAg positive over a period of 4 months, at intervals not longer than monthly. [1, 63] Hepatitis B immunoglobulin (HBIG) should be considered for those patients who do not respond to the HBV vaccine. [1, 63]

4.5.3 Patients at risk of contracting HCV from a newly infected individual should be monitored for any sero-conversion to become anti-HCV-positive over a period of 6 months, [31] at intervals of no longer than 3 months. Testing for HCV RNA may be considered. [42]

Table 2: Recommended schedule of BBV serological screening for dialysis patients

	Prior to 1st dialysis session	**Semi-annual**	**Annual**
All Patients	HBsAg*, anti-HBs, anti-HBc# anti-HCV, ALT, anti-HIV (*HD & PD)*		
HBsAg -ve, anti-HBs -ve and anti-HBc -ve		HBsAg (*HD*)	HBsAg (*PD*)
anti-HBs +ve (≥ 10mIU/mL), anti-HBc -ve			anti-HBs (*HD*)
anti-HBs and anti-HBc +ve		HBsAg *(HD)*	
HBsAg +ve			HBsAg (*HD*)†
Isolated anti-HBc +ve		Please refer to Questions 1 and 2 of Appendix A: Frequently Asked Questions	
anti-HCV -ve		anti-HCV, ALT *(HD)*	

Remarks:

* Result of HBsAg should be known before the patient begins dialysis

Test anti-HBc for occult HBV infection, for haemodialysis patients only

† If HBsAg turns from positive to negative, testing of anti-HBs and HBV DNA is necessary to delineate the infectivity.

HD: Haemodialysis patients

PD: Peritoneal dialysis patients

Table 3: Interpretation of HBV Test Results [4, 74]

HBsAg	Anti-HBc	IgM Anti-HBc	Anti-HBs	Interpretation	Action
-	-	-	-	Susceptible	Receive HBV vaccination
+	+	+	-	Acute infection or viral reactivation of chronic infection	Check HBsAg 6 months later and manage accordingly
-	+	-	+	Past infection, recovered and immune or occult HBV infection	Continue annual anti-HBs testing (HD) and check HBV DNA
+	+	-	-	Chronic infection	Clinical evaluation for complications +/- treatment
-	+	-	-	False positive (i.e., susceptible), past infection, or occult HBV infection	Repeat serology test & check HBV DNA (See Appendix A FAQ Q1&2)
-	-	-	+	Immune if titer is ≥10mIU/mL	Continue annual anti-HBs testing (HD)

Table 4: Interpretation of HCV Test Results [4]

Anti-HCV	HCV-RNA	Interpretation	Action
+	+	• Acute hepatitis C • Chronic hepatitis C	Clinical evaluation and consider to start treatment
+	-	• Resolved hepatitis C • Acute HCV during low-level viremia • False-positive anti-HCV test • False-negative HCV-RNA test	HCV-RNA test every 6 months
-	+	• Early acute HCV • Chronic HCV in a setting of immunosuppressed state • False-positive HCV-RNA test	Clinical evaluation and consider to start treatment
-	-	• No infection	Anti-HCV test every 6 months (HD)

5. IMMUNISATION

5.1 Hepatitis B Vaccination

Hepatitis B vaccination is recommended for all susceptible chronic haemodialysis patients and for all staff members. [31, 42]

Primary vaccination comprises three intramuscular doses of vaccine, with the second and third doses given at 1 and 6 months respectively after the first dose. Vaccines containing recombinant HBsAg are available to provide protection against HBV infection.

5.1.1 Patients

Patients with renal failure are potentially at increased risk of HBV infection because of their need for long-term haemodialysis. Prevention of HBV in renal patients is recommended. [31]

a. Patients with progressive renal failure should be considered for hepatitis B vaccination for better antibody response if chronic dialysis is anticipated.

b. For patients undergoing haemodialysis or immunosuppressed patients, higher vaccine dosages or increased number of doses are required. [1, 75] Alternatively, the vaccine may be administered intradermally instead of the conventional intramuscular route. [42] Topical application of imiquimod prior to intradermal injection of vaccine may enhance immune response in dialysis patients. [76]

c. Antibody responses to the HBV vaccine vary widely between individuals. Antibody responses should be checked 1-4 months after a course of vaccine. [63]

d. A booster dose is indicated when the anti-HBs level declines to <10 mIU/mL upon annual anti-HBs testing. [1, 42, 77]

e. Persons who do not respond to the primary vaccine series (anti-HBs level <10 mIU/mL and HBsAg -ve) should be revaccinated with 3 additional doses and retested for antibody response. [31, 75] No additional doses of vaccine are warranted for those who do not respond to the second series.

5.1.2 Staff

a. All staff who work in the dialysis unit should be encouraged having their immune status for HBV checked at the initial employment. [42, 63]

b. Both employer and employee are recommended to keep a serological testing and vaccination record.

c. Staff susceptible to HBV infection (HBsAg and anti-HBs both negative) are recommended to undergo vaccination. [42]

5.2 Influenza Vaccination

Influenza is a common viral illness and is associated with significant mortality and morbidity. [78, 79] In Hong Kong, influenza is more prevalent from January to March and from July to August. Influenza affects the general population; while infection in certain high risk groups, including patients with chronic renal failure, is associated with higher morbidity and mortality rates. [80, 81]

Influenza vaccination is one of the effective means in preventing influenza and its complications together with reduction in influenza-associated hospitalisation and death. In Hong Kong, registered Seasonal Influenza Vaccine (SIV) include inactivated influenza vaccines (IIV), a live attenuated influenza vaccine (LAIV), as well as a recombinant influenza vaccine (RIV). [80]

SIV requires annual administration. Evidence on repeated influenza vaccination shows that vaccination in the current and prior season provides better protection than no vaccination or being vaccinated in the prior season only. [82]

People should receive influenza vaccination annually at least 2 weeks prior to the anticipated seasonal peak of influenza. The government influenza vaccination programme aims at protecting persons at high risk for complications and healthcare workers from infection. [80]

5.2.1 Patients

World Health Organization (WHO) recommends that priority for influenza vaccination be given to those at highest risk of developing serious complications from influenza. [82, 83]

In Hong Kong, influenza vaccination is recommended for persons with chronic illness, such as renal diseases, to prevent influenza-associated complications and mortality. [80]

5.2.2 Staff

WHO and international health authorities recommend that healthcare workers should receive annual influenza vaccination to reduce the risk of influenza transmission. [80, 82, 84, 85]

5.3 Pneumococcal Vaccination

Invasive pneumococcal diseases (IPD) caused by *Streptococcus pneumonae* include septicaemia, meningitis and empyema. Nephrotic syndrome is the renal disease that is most clearly associated with an increased risk of pneumococcal infection. [86, 87]

The CDC recommends vaccinating the persons who are at increased risk of pneumococcal disease or its complications, including patients with chronic renal failure. [4, 88]

5.3.1 In Hong Kong, pneumococcal vaccination is recommended for those at risk of severe IPD, including persons with chronic renal diseases. [17]

5.3.2 There are two types of pneumococcal vaccines available in the market, namely a 23-valent pneumococcal polysaccharide vaccine (23vPPV) and pneumococcal conjugate vaccines (PCV). The recommendations to high risk individuals from the Scientific Committee on Vaccine Preventable Diseases (SCVPD) are as follows: [17]

a. For those who have already receive a single dose of PCV13, a single dose of 23vPPV should be administered 1 year later.

b. For those who have already received 23vPPV, a single dose of PCV13 should be administered 1 year later.

c. For those who have not received any pneumococcal vaccines, a single dose of PCV13 should be administered, followed by a single dose of 23vPPV 1 year later.

5.3.3 The latest pneumococcal conjugate vaccine recommended for government pneumococcal vaccination programme is PCV15. PCV15 can be used as a direct replacement for PCV13 at any point during the course of immunization. [89]

a. Individuals may choose to receive PCV20 to protect themselves against IPD. [89] If PCV20 is used, it does not need to be followed by a dose of 23vPPV. [90]

5.4 Coronavirus Disease 2019 Vaccination

5.4.1 Coronavirus disease 2019 (COVID-19) is the disease caused by a new coronavirus called "SARS-CoV-2". People of older age and those having chronic renal disease and other underlying medical problems (e.g. hypertension, heart and lung problems, diabetes, obesity or cancer) are at higher risk of developing serious illness. [91]

5.4.2 Vaccination is the most effective measure to stop the spread of the virus and prevent severe cases, hospitalisation and death. Local data showed that three doses of COVID-19 vaccines (i.e. Comirnaty or CoronaVac vaccine) are highly effective in reducing hospitalisation and death across all age groups in the adult population. [92]

5.4.3 Taking into account the latest scientific evidence, overseas and local recommendations, the SCVPD and the Scientific Committee on Emerging and Zoonotic Diseases (SCEZD) under the Centre for Health Protection of the Department of Health and Chief Executive's expert advisory panel (JSC-EAP) recommended another booster to be given at least 6 months after the last dose or COVID-19 infection (whichever is later) for the high risk priority groups, including persons with kidney disease. [92]

5.4.4 In view of scientific development on COVID-19 vaccines and continuous update of vaccination recommendations from overseas health authorities, it is recommended to keep track on the latest local vaccination strategies issued by the SCVPD.

6. WATER TREATMENT SYSTEM

Components of the dialysis system that are potentially contaminated by microbes include the water treatment system and the water and dialysate distribution systems. [93] Following recommended standards for the preparation of dialysate and the operation of water treatment equipment is essential for patient safety, quality control and prevention of infections.

6.1 Water Treatment and Distribution System

The water treatment system includes the collection of water purification devices and its associated piping, pumps, valves and gauges. It produces purified water for haemodialysis and delivers it to the point of use, including individual haemodialysis machines.

6.1.1 Piping and plumbing system

a. All dialysis system piping should be readily accessible for inspection and maintenance. The pipework rings should be installed above the floor in the dialysis area and the maintenance room. Installations that utilise ceiling or floor voids are not advised. [94, 95]

b. Consideration should be given to the disposal of dialysis effluent from the dialysing process to prevent odour and backflow. [94]

c. The supply of potable water for handwashing stations should be separated from the water supply for haemodialysis, of which the supply and drainage would not be interfered should the supply of potable water be disrupted. [94]

6.1.2 Whenever practical, design and engineer water systems in dialysis settings to avoid incorporating joints, dead-end pipes, and unused branches and taps that can harbour bacteria. [93] The use of suitable inert material such as stainless steel, cross-linked polyethylene or polypropylene is crucial to ensure water quality. Copper, brass, aluminum, lead, zinc or other similar materials are not suitable and should be avoided. The pipework should be capable of being cleaned and / or disinfection by either chemical or heat treatment to maintain hygiene. [95]

6.1.3 Storage tanks are not recommended for use in dialysis systems unless they are routinely drained, disinfected with an U.S. Environmental Protection Agency (EPA) registered product, and fitted with an ultra filter or pyogenic filter (membrane filter with a pore size sufficient to remove small particles and molecules >1 kilodalton) installed in the water line distal to the storage tank. [93, 96, 97] The filter should be changed on a regular basis according to the manufacturer's instruction. [98]

6.1.4 Disinfect water distribution systems in dialysis units with either hot water or chemical germicide, according to the manufacturer's recommendations, at least monthly, to prevent bacterial contamination. [93, 99]

6.1.5 Disinfect the reverse osmosis (RO) systems in accordance with the manufacturer's recommended procedures and intervals, and after technical interventions. [100]

6.1.6 Regular monitoring of backwashing / regeneration of the pre-conditioning system of the water treatment plant.

6.1.7 Haemodialysis procedure MUST NOT be performed during disinfection of the water treatment system and the loop. [63]

6.1.8 Written procedures on disinfection and confirmed absence of residual disinfectants have to be in place if chemical disinfection is performed.

6.1.9 Install a central station monitor or alarm system for the water treatment plant and set a warning for low levels. [63]

6.1.10 Any amendments to the procedure guidelines have to be agreed upon by the head of the dialysis centre as well as the equipment manufacturer when appropriate. [63]

6.1.11 Staff should strictly adhere to procedure guidelines. Deviations from the guidelines without sound reasons and prior approval from the head of the dialysis centre should not be allowed. [63]

6.1.12 A contingency plan should be in place for unexpected disruptions to the water supply, so as to avoid service breakdown during maintenance of the water system. Good communication channels with the Water Supplies Department should also be established.

6.1.13 For the prevention and control of Legionnaires' Disease, please refer to "Code of Practice for Prevention of Legionnaires' disease" issued by the Prevention of Legionnaires' Disease Committee for details. [101]

6.2 Haemodialysis / Haemodiafiltration Machines

Haemodialysis is a form of renal replacement therapy in which waste products are removed primarily by diffusion from blood flowing on one side of a membrane into dialysate flowing on the other side. [98]

Haemodiafiltration is also a form of renal replacement therapy in which waste solutes are removed from the blood by a combination of diffusion and convection through a high-flux membrane. [98]

6.2.1 For most dialysis machines, routine disinfection with hot water or with a chemical germicide connected to a disinfection port on the machine does not disinfect the line between the outlet from the water distribution system and the back of the dialysis machine. Users should establish a procedure for regular disinfection of this line. [98]

6.2.2 Follow the manufacturer's guidelines on disinfection procedures. [63] It is desirable to disinfect the dialysis machines together with the distribution loop by central heat disinfection.

6.2.3 Ensure that the haemodialysis machine is disinfected after use, before sending for repair / maintenance, after repair / maintenance work or when the recommended interval from the last disinfection is exceeded.

6.2.4 Ensure each dialysis machine is rinsed and tested for the absence of residual germicide if chemical disinfection is used. [93]

6.2.5 Ensure that relevant procedural guidelines on the preparation of the haemodialysis machine for haemodialysis are in place. [63]

6.2.6 Routine disinfection of active and backup dialysis machines is performed according to defined protocol. Documentation of the absence of residual disinfectants is required for machines requiring chemical disinfectants. [63]

6.3 Quality of Water for Dialysis

Contaminants commonly found in tap water are toxic to haemodialysis patients. To prevent harm from these contaminants, standards for the quality of water used to prepare dialysate have been developed. There are variations in the recommended maximum allowable levels of microbiological contaminants in water used for haemodialysis, as well as the methods used to measure them in different countries. Harmonisation of existing standards may improve patient safety by promoting best practices.

(Please refer to Table 5)

6.3.1 Microbiological contaminants

Regular microbiologic sampling of dialysis fluids is recommended because gram-negative bacteria can proliferate rapidly in the water and dialysate in haemodialysis systems. High levels of these organisms place patients at risk for pyrogenic reactions or healthcare-associated infections. [93]

a. Perform bacteriologic assays of water and dialysate at least once a month and during outbreaks / equipment change using standard quantitative methods. [38, 93]

- Assay for heterotrophic, mesophilic bacteria (e.g. Pseudomonas species). [93]
- Use non-nutrient culture media (tryptone glucose extract agar (TGEA) or Reasoner's 2A) to detect bacteria in haemodialysis water and dialysate. [102] They should be cultured at 17ºC to 23ºC for 168 hours (7 days). [102] For central sodium bicarbonate preparation and distribution systems, the cultivation medium should be supplemented with 4% sodium bicarbonate. [102]
- Do not use nutrient-rich media (e.g. blood agar or chocolate agar). [93, 102] A nutrient-rich environment is not appropriate for culturing organisms that have adapted to a purified water environment. [103]

b. Both the water used to prepare dialysate and the dialysate solution shall contain a total viable microbial count lower than 100 CFU/mL. [102, 104, 105]

c. If the bacterial count in dialysis water or in dialysate is ≥50 CFU/mL, disinfection and retesting should be commenced immediately. [102, 104, 105]

d. For centres practicing on-line haemodiafiltration, the microbial count should be less than 1 CFU/mL for samples taken at pre-filter (ultra-filter) sites and 0.1 CFU/mL at the infusion port. Special culture method should be used to increase sensitivity. [106]

6.3.2 Endotoxin contaminants

Endotoxin is a complex lipopolysaccharide-containing material derived from the outer cell wall of gram-negative bacteria. In the human blood-stream, endotoxin can cause fever (pyrogenic reaction), coagulation and circulatory disturbances, and severe consequences such as bacteraemic or endotoxic shock. [107] Gram-negative bacteria (e.g. *Pseudomonas* species) have been shown to multiply rapidly in a variety of hospital-associated fluids that can be used as supply water for haemodialysis (e.g. distilled water, deionised water, RO water and softened water) and in dialysate. [93]

CDC has advocated monthly endotoxin testing along with microbiologic assays of water, because endotoxin activity may not correspond to the total heterotrophic plate counts. [93]

a. The endotoxin concentration of the RO water and dialysate should be monitored using appropriate method such as the limulus amoebocyte lysate (LAL) test or other equivalent methods at least once a month. [42, 93]

b. The endotoxin concentration in RO water should be less than 0.25 IU/mL, and should be less than 0.5 IU/mL in the dialysate. [102, 104, 105]

c. If the endotoxin concentration is ≥0.125 IU/mL in the RO water or ≥0.25 IU/mL in the dialysate, disinfection and retesting should be commenced immediately. [102, 104, 105]

d. For centres practicing haemodiafiltration, the maximum allowable level for endotoxin in dialysate should be lower, at <0.03 IU/mL. For online haemodiafiltration, in addition to dialysate, the substitution fluid should also have endotoxin level <0.03 IU/mL. [42, 104]

* Note that the above levels were recommendations, rather than requirements. [42, 103]

6.3.3 Sample collection

a. Samples should be analysed as soon as possible after collection to avoid unpredictable changes in the microbial population. If samples cannot be analysed within 4 hours of collection, they should be stored at <10°C without freezing until ready to transport to the laboratory for analysis. Sample storage for more than 24 hours should be avoided, and sample shipping should be in accordance with the laboratory's instructions. [100]

b. Follow proper procedures to collect samples to prevent potential contamination which may lead to false positive result:

- rinse sampling ports for at least 1 minute at normal pressure and flow rate before using a "clean catch" technique to collect samples [108] or

- aspirate samples with needles from the sampling ports of dialysis machines aseptically following manufacturer's instructions. [102] Sample ports should be disinfected with alcohol pads and allowed to air dry before the sample is drawn. [102]

c. Sample testing should be performed monthly on the water treatment system; and at least annually on dialysis machines. [108]

6.3.4 For monitoring of the water distribution system, samples should be taken from the first and last outlets of the water distribution loop, the outlets supplying reuse equipment and bicarbonate concentrate mixing tanks. [98]

6.3.5 If the results of these tests are unsatisfactory, additional testing (e.g. on the ultra-filter inlet and outlet, RO product water, and storage tank outlet) should be undertaken so as to identify the source of contamination. [98]

6.3.6 For a newly installed water distribution piping system, or when a change has been made to an existing system, it is recommended that weekly testing be conducted continuously for 1 month to verify that bacteria or endotoxin levels are consistently within the allowed limits. [98] The test(s) should be performed according to the manufacturer's recommendation.

6.3.7 After installing a water treatment, storage and distribution system, the user is responsible for continued monitoring of bacterial levels of the system to comply with the requirements of this standard. [98]

6.3.8 All bacteria and endotoxin results should be recorded on a log sheet to identify trends and the need for corrective action. [98] Any such actions should also be recorded if indicated. [63]

6.3.9 In home dialysis setting and some acute care setting, dialysis may be done in the patient room using a portable RO water treatment system. Water and dialysate used for this treatment must meet the same standards as those provided for in-center treatment. [4]

6.3.10 For portable RO systems used for home haemodialysis, monitoring of the viable microbial count and endotoxin concentration in the RO water and dialysate should be done at least every 3 months. [104]. For portable RO system used for haemodialysis in in-centre/hospital settings, the frequency of microbiological monitoring should be same as the central RO system in these settings, i.e. monthly. [109, 110]

6.3.11 There are portable RO systems that have been developed

which incorporate an exchangeable cartridge that produces RO water. Testing frequency for these systems should be the same as for portable systems. [38]

Table 5: Recommended sampling and limit levels for quality of dialysis fluids for haemodialysis [42, 102, 104, 105]

			Total viable microbial count		**Endotoxin concentration**	
Setting	**Fluid type**	**Testing frequency**	**Maximum allowable level**	**Action level***	**Maximum allowable level**	**Action level***
In-centre / hospital	Dialysis water	Monthly	<100 CFU/mL	≥50 CFU/mL	<0.25 IU/mL	≥0.125 IU/mL
	Dialysate	Monthly	<100 CFU/mL	≥50 CFU/mL	<0.5 IU/mL	≥0.25 IU/mL
	Dialysate (haemodiafiltration)	Monthly	<0.1 CFU/mL	NA	<0.03 IU/mL	NA
	Substitution fluid (online haemodiafiltration)	Monthly	<0.1 CFU/mL	NA	<0.03 IU/mL	NA
Portable RO system# (Home HD)	RO water	Every 3 months	<100 CFU/mL	≥50 CFU/mL	<0.25 IU/mL	≥0.125 IU/mL
	Dialysate	Every 3 months	<100 CFU/mL	≥50 CFU/mL	<0.5 IU/mL	≥0.25 IU/mL

*Action level indicates that once these levels are measured in the testing samples, corrective measures should be promptly taken to reduce the levels of bacteria / endotoxins.

For portable RO system used for haemodialysis in in-centre/hospital settings, the frequency of microbiological monitoring should be same as the central RO system in these settings, i.e. monthly.

7. INFECTION CONTROL PRACTICES IN RENAL UNITS

Infection control precautions should be tailored to prevent transmission of viruses and pathogenic bacteria within specific patients and settings. In addition to Standard Precautions, more stringent precautions are recommended for renal units because of the increased risk of contamination with blood and pathogenic microorganisms.

7.1 Facility Setting

7.1.1 Allow adequate room for daily operations, lighting and staff so as to ensure safe working practices. [1, 63]

7.1.2 Staff members should have designated areas to rest, eat and drink. [1, 42]

7.1.3 Assign designated areas for removal of PPE and decontamination of hands upon leaving the clinical area of the unit.

7.1.4 Assign designated clean areas for the preparation, handling and storage of medications, supplies and equipment. [31, 38]

7.1.5 Clean areas should be clearly separated from contaminated areas where used equipment and supplies are handled. [31]

7.1.6 Hand hygiene facilities should be easily accessible.

7.1.7 Separate rooms are recommended for peritoneal dialysis training and care of complications related to CAPD. [14]

7.1.8 Assign designated rooms / cubicles / areas for potentially infectious patients, or cohort patients with the same pathogen in the renal unit.

7.1.9 Assign designated areas for equipment repair and maintenance.

7.2 Hand Hygiene

Hand hygiene has been frequently cited as the single most important practice to reduce the transmission of infectious agents in healthcare settings [42] and is an essential element of Standard Precautions.

The term "hand hygiene" includes both hand washing with soap and water, and use of alcohol-based hand rub.

7.2.1 Five crucial moments of hand hygiene are promoted by WHO: [8]

a. Before touching a patient

b. Before clean / aseptic procedures

c. After body fluid exposure risk

d. After touching a patient

e. After touching patient surroundings

7.2.2 All patients and visitors should perform hand hygiene on entering and leaving the dialysis unit.

7.2.3 Wash hands with soap and water when hands are visibly soiled with dirt or organic material, such as after touching blood, body fluids (e.g. PD fluid / dialysate fluid), secretions, excretions and contaminated items. [8, 38]

7.2.4 When hands are not visibly soiled, alcohol-based hand rub can be used. [8, 31, 38]

7.2.5 Perform hand hygiene after touching a surgical mask / N95 respirator or before touching the face (especially the eyes, nose and mouth). [8]

7.2.6 Provision of resources

a. Sufficient number of sinks with liquid soap, disposable paper towels and water should be consistently available to facilitate hand washing. [8, 31, 38]

b. Alcohol-based hand rub should be made available and easily accessed by staff in renal units, such as at every patient's bed side and at every nursing station within the unit. [8, 38]

c. Provide waste containers for the disposal of used paper towels. [8]

7.2.7 Hand hygiene technique

a. "Bare below the elbow" policy is recommended in clinical practices. [111]

b. Clean hands properly according to the procedures listed in Appendix B.

7.3 Personal Protective Equipment

PPE refers to a variety of barriers and respirators that are used alone or in combination to protect mucous membranes, airways, skin, and clothing from contact with infectious agents. During the procedure of haemodialysis, initiation or termination of dialysis, exposure to blood, body fluids and potentially infectious items is anticipated. Therefore, proper usage of PPE is extremely important in renal units.

The selection of PPE is based on the nature of patient contact and / or the likely mode(s) of transmission. [111]

7.3.1 Gloves, gowns, surgical masks, eye protection (e.g. goggles / face shields) should be readily available. [4]

7.3.2 Staff should put on appropriate PPE when handling dialysate / PD effluent. [63]

7.3.3 Both staff and patients should wear masks when their dialysis catheter lumens are exposed. [4, 112]

7.3.4 Sterile gloves should be used during procedures requiring sterile aseptic technique, such as performing dialysis catheter exit site dressing and cannulation. [38]

7.3.5 PPE should be changed at the earliest opportunity if they become visibly splashed with blood [1] or body fluids.

7.3.6 Staff should perform hand hygiene, change gloves and gowns if used between patients / stations, or different procedures for the same patient (e.g. moving from a contaminated to a clean body site). [1, 38]

7.3.7 Don and remove PPE in designated areas to avoid contamination.

7.3.8 Remove PPE and perform hand hygiene with the proper techniques (please refer to Appendix B) after procedures or on leaving the work area.

7.3.9 Used PPE should be disposed into lidded waste containers.

7.4 Equipment and Instrument

The risk of transmission is increased if equipment and inanimate surfaces have not been adequately cleaned between dialysis sessions. Staff should pay attention to the possibility of blood contaminating equipment and dialysis machines, and the need to ensure that all used equipment and machines are adequately decontaminated before reuse.

7.4.1 Items or clinical equipment used in a patient's dialysis station should be disposed of; or dedicated for use on the single patient; or disinfected before they are returned to the common clean area or used on another patient. [11, 31, 40, 83]

7.4.2 The entire dialysis fluid circuits of the dialysis machines should be decontaminated between patients by heat or chemical disinfection according to the manufacturer's instructions. [1] Dialysis machines should be cleaned and disinfected internally and externally, also according to the manufacturer's instructions. [1, 11, 38]

7.4.3 Medical items labeled for "single use" should not be reused.

7.4.4 Reused medical instruments (e.g. scissors, haemostats, clamps, stethoscopes, blood pressure cuffs) should be thoroughly cleaned before disinfection. [38]

7.4.5 Appropriate PPE should be worn during decontamination procedures. For recommendations of appropriate PPE, please refer to section 7.3 of this document.

7.4.6 Minimise storage of equipment close to dialysis machines and patients. [38]

7.5 Medications

7.5.1 Perform hand hygiene before and after handling of medications.

7.5.2 Prepare the medication in the designated clean area.

7.5.3 Do not handle and store medications / clean supplies in the same or adjacent area that used equipment or blood samples are handled. [38]

7.5.4 Medication from a syringe must not be administered to other patients even if the needle on the syringe is changed.

7.5.5 All single-use injectable medications and solutions should be dedicated for use on a single patient and be given once only. [38]

7.5.6 Medications packaged as multi-dose preparations should be prepared in the designated clean area and delivered separately to each patient. [40]

7.5.7 Medications taken to the patient area or dialysis station should be used only for that patient and should not be returned to a common clean area or used on other patients. [38]

7.5.8 All infusion fluids, administration sets (intravenous tubings and connections) and pressure transducer setups are single-use devices. Contamination cannot be ruled out by visual inspection.

7.5.9 Common carts should not be used within the patient area to prepare or distribute medications.

7.6 Environmental Control

Inanimate environments are well documented to be a reservoir for microorganisms. Direct or indirect contact with the patient's immediate environment poses a major risk of cross contamination and spread of nosocomial infections. Cleansing of environmental surfaces is fundamental to reduce their potential contribution to infections. [83]

7.6.1 Environmental cleansing and disinfection

a. Supporting staff should understand the precautions for minimizing exposure risk to potentially infectious materials. [113]

b. Routine cleaning is important to ensure a clean and dust-free hospital environment. Clean and disinfect the dialysis stations (e.g. chairs, beds, tables, machines and control panels) between patients with 1 part of household bleach (5.25% sodium hypochlorite solution) in 99 parts of water, or equivalent environmental disinfectants. [113]

c. Place all used dialysers and tubings in leak-proof containers during transport from stations to the disposal area. [1]

7.6.2 Handling of blood spillages

a. Staff should be trained to deal with blood spillages properly. [31]

b. Appropriate PPE should be worn when handling spills, such as eye protections, disposable gloves and gowns.

c. Clean the visible matter with disposable absorbent material. Mop the area with a cloth or paper towels wetted with 1 part of household bleach (5.25% sodium hypochlorite solution) in 4 parts of water, then leave for 10 minutes before rinsing with water. [113]

d. Remove PPE and perform hand hygiene after the procedure.

7.6.3 Handling of body fluids spillages

a. Staff should be trained to deal with body fluids spillages properly.

b. Appropriate PPE should be worn when handling body fluids, such as eye protections, disposable gloves and gowns.

c. For body fluids such as dialysate, peritoneal dialysis fluid or vomitus, cleanse the visible matter with disposable absorbent material. Mop the area with a cloth or paper towels with 1 part of household bleach (5.25% sodium hypochlorite solution) in 49 parts of water, then leave for 15-30 minutes before rinsing with water. [113]

d. Remove PPE and perform hand hygiene after the procedure.

7.7 Waste Management

7.7.1 Waste disposal

a. Supporting staff in dialysis units should promptly remove soiled items and wastes, maintaining an environment that enhances patient care. [31]

b. Surgical dressings, swabs and all other waste dribbling with blood, caked with blood or containing free-flowing blood should be treated as clinical waste and discarded into red waste bags. [114]

c. Bags used for clinical waste should be leak-proof, [31, 114] impervious to moisture, and strong enough to prevent tearing or bursting. [114]

d. Waste containers should be lidded and foot or sensor operated. These should be available at the point of use. [38]

7.7.2 Sharps disposal

a. All staff should handle sharps with care and great caution to avoid injury.

b. Each staff member performing procedures in which sharp instruments are used is responsible for ensuring immediate safe disposal. [1]

c. Sharps boxes should be available at the point of use.

d. Used sharps, such as dialysis needles, should not be re-sheathed or recapped. They should be discarded immediately in a safe manner into a sharps box. [1]

e. Sharps boxes should be puncture-resistant. They should not be over-filled above the warning line indicating between 70% and 80% of its maximum volume and should be well covered and properly sealed prior to disposal to prevent leakage. [1, 38, 114]

f. Sharps box is classified as clinical waste. It has to be properly labelled before disposal. [114] Please refer to the Environmental Protection Department for relevant legislative requirements.

7.7.3 Disposal of PD effluent / dialysate

a. All staff should follow the unit's guidelines for proper handling of PD effluent / dialysate with great caution to avoid splashing.

b. PD fluid should be disposed directly into a drain or by pouring carefully into a sluice. [1]

c. Discard the emptied CAPD bag with tubing into a black waste bag.

7.7.4 Disposal of haemodialysis fluid

Used haemodialysis fluid should be disposed directly into a drain.

8. HOME DIALYSIS

Home haemodialysis has its origins in the 1960's. The number of patients on peritoneal dialysis has increased since the development of CAPD in the late 1970's and the introduction of continuous cycling peritoneal dialysis (CCPD) in the 1990's.

Home dialysis offers patients self-control, self-esteem, best survival and less exposure to hospital-acquired infections. [51, 63, 115] Cross infections should be rare. [13, 116, 117] Scheduling is flexible and travel to a health centre is eliminated.

There are no major differences between infection control practices in the home dialysis setting and healthcare facilities. Some recommendations are highlighted below for successful home dialysis.

8.1 Home Haemodialysis

More patients can undergo haemodialysis by themselves at home if training and support services are available together with the advancement of more patient-friendly machines. The advantages of home haemodialysis, such as better clinical response and quality of life, with extended hours of haemodialysis done at the patient's convenience, far outweigh its financial considerations. [115, 118-120]

8.1.1 Patients must have a vascular access that is easy to use. [115] A satisfactory AVF for repeated punctures by the patient himself or a household member is preferred. [63]

8.1.2 Rope-ladder cannulation is preferred to buttonhole cannulation method to minimise the risk of access infection. [42, 121]

8.1.3 If buttonhole cannulation technique is used, the use of topical antimicrobial prophylaxis over the cannulation sites is suggested. [121]

8.1.4 The patient / household member should be trained by experienced staff in the proper setting up of dialysis equipment, care of the dialysis access, asepsis during initiation of and after haemodialysis procedures, care and maintenance of equipment and supplies (including cleaning and disinfection), recognition of signs of infection, and infection control procedures (including hand hygiene, waste disposal and handling of blood spillage). [13, 31, 116, 122]

8.1.5 The patient / household member should be educated to designate a clean area for the preparation, handling and storage of medications, dialysate and equipment. [13, 31, 116, 117] This designated haemodialysis area should be free from plants and pets.

8.1.6 The home should be surveyed before starting training to ensure there is an appropriate area to install the equipment, with adequate electricity, water supply and drainage, and the availability of a phone which is easily accessible for patient's use. Any necessary home modifications should be done. [115]

8.1.7 Skilled and experienced staff should be available for patient consultation at all times. [51, 115]

8.1.8 The patient should complete dialysis log sheets. The patient / household member should be trained to handle emergencies. [115]

8.1.9 Regular disinfection, maintenance and water bacteriological testing of haemodialysis and RO machines should be performed.

8.1.10 Quality of RO water and dialysis fluid for home dialysis should be the same as it is for in-centre haemodialysis. [42]

8.1.11 The total viable microbial count and endotoxin concentration of the RO water and dialysate should be monitored at least every 3 months. [104]

8.1.12 The family members of HBsAg positive patients are advised to test their HBsAg and anti-HBs status. If both HBsAg and anti-HBs are negative, they are advised to receive Hepatitis B vaccination.

8.2 Home Peritoneal Dialysis

Many patients can continue to use peritoneal dialysis successfully for many years before it fails, usually due to repeated infection and loss of the peritoneal membrane's surface area or function (peritoneal failure). Special care must therefore be taken by the patient to prevent infections. [123]

8.2.1 The patient should perform peritoneal dialysis in an area which is free from pets. [69, 124-129] Dialysis equipment, tubing and machines should be properly stored to prevent contamination or damage by pets. [69]

8.2.2 The patient / household member should be trained by experienced staff for proper dialysis procedures.

8.2.3 The patient should be educated on general and healed PD exit site care; the site should be examined and cleaned at least daily or whenever soiled. [123]

a. Wash hands or use an alcohol-based hand rub; wear clean gloves if indicated, such as when handling soiled dressings.

b. Remove the dressing, if present and perform hand hygiene.

c. Check the exit site for redness, swelling, drainage or soreness.

d. Check the catheter for cracks or tears.

e. Gently touch the catheter tunnel, noting the presence of swelling, discharge or pain.

f. When showering, clean the skin around the catheter with antibacterial liquid soap and rinse.

g. Secure the catheter to the abdomen by using immobiliser or tape to avoid tension on the catheter and trauma on the exit site.

8.2.4 The patient should avoid all fresh water activities (e.g. in lakes, rivers and streams), swimming, hot tubs, jacuzzis, soaking tubs and public pools to prevent gram-negative catheter-related infections and peritonitis.

8.3 Management of Waste and Environmental Cleaning at Home

8.3.1 Reuse of single-use device is not recommended.

8.3.2 Waste generated from home dialysis patients can be regarded as household waste (municipal waste).

8.3.3 The extracorporeal blood circuit should be capped to form a closed system for disposal in a garbage bag after the blood cells in it had been returned to the patient.

8.3.4 The emptied PD bag with tubing should be discarded into a garbage bag after it had been properly clamped.

8.3.5 The sharps box (container) should be puncture-resistant and should not be over-filled above 70% to 80% of its maximum volume. The filled box should be well covered and properly sealed for disposal. [1]

8.3.6 Non-critical items (e.g. blood pressure cuffs, dialysis chairs) can be cleaned with detergent. Clean all machines and surfaces with detergent prior to and after use. Blood spills should be handled as previously described as in section 7. Sterilisation of critical items is not practical at home. [123]

9. OCCUPATIONAL SAFETY AND HEALTH

Healthcare personnel are at risk of occupational hazards such as blood and body fluid exposure, sharps injuries or exposure to harmful chemicals in the hospital's work environment.

Training in health and safety should ensure that workers recognise and understand the potential risks of healthcare-associated infections. A comprehensive policy for the management of blood exposure incidents and their reporting to the occupational health authorities should be established. These incidents should be monitored, and relevant procedures or equipment should be modified if necessary.

9.1 Blood and Body Fluid Exposure

Exposure to blood-borne pathogens, e.g. HBV, HCV and HIV, may occur through needle-stick injuries by sharp instruments that are contaminated with an infected patient's blood, or through mucosal contact with a patient's blood. [130]

9.1.1 Nature of injury

a. Sharps injury

Care should be taken to avoid injury when dealing with any sharp instruments such as dialysis needles, particularly when they are contaminated with blood or body fluids. Sharps injuries are often associated with these activities: [131]

- Recapping needles.
- Transferring body fluids between containers using sharp devices (such as a syringe and needle).
- Failing to dispose used needles properly in a puncture-resistant sharps box.

b. Blood or body fluids spills

Accidental exposure to spills of blood or body fluids may expose the healthcare worker to BBV or other pathogens.

9.1.2 Prevention of occupational infections

In the haemodialysis setting, exposure to blood and potentially contaminated fluids can be anticipated. Standard precautions are recommended when caring for all patients.

a. General precautions for prevention of sharps injury and blood or body fluid exposure:

- Vaccination should be given to prevent infections such as HBV. [130]
- Staff should cover any cuts and abrasions with waterproof dressings.
- Using appropriate PPE such as gloves, eye and face protections, gowns to prevent potential exposures to the eyes, nose, mouth, or skin when contact with blood or body fluids is expected, especially when splash or spray may happen. [42, 130]
- Perform hand hygiene after contact with blood or body fluids.

b. In addition, sharps injuries can be prevented by: [130]

- Using safer techniques.
- Disposing of used needles and sharp devices in a sharps box immediately.
- Using medical devices with safety features designed to prevent injuries.

9.1.3 Management of occupational blood exposures [132]

a. Immediate care after exposure

- Wash wounds and skin with soap and water.
- Flush mucous membranes with water.
- Report the incident to your supervisor.
- Immediately seek medical treatment. [132]

i Determine the risk associated with the exposure by type of fluid and nature of exposure.

ii Evaluate the source of exposure.

iii Evaluate the exposed person.

b. Provide relevant follow-up testing and counselling based on the above assessments. [132]

9.2 Chemical Disinfectants

Chemicals may exert either acute or chronic effects on workers. The consequences depend on extent of exposure, the route of exposure, and the physical and chemical properties of the substances.

9.2.1 Staff should be trained on how to handle the chemical disinfectants. Supporting staff should be supervised when they are handling chemicals.

9.2.2 Personnel should take appropriate precautions when handling chemical disinfectants. (please refer to Table 6)

9.2.3 Users should observe the product information and other relevant details, including chemical labelling, Material Safety Data Sheet (MSDS) and emergency preparedness. Proper measures for controlling chemical exposures and spillage should be applied accordingly. [13]

9.2.4 PPE should be used when the risk could not be lowered by appropriate risk control measures.

9.2.5 Risk assessment should be conducted with respect to particular tasks.

Table 6: Common chemicals used in renal units

Chemicals	Hazards	General Precautions
Alcohol (70%)	• Flammable	• Handle in a well-ventilated area • Keep away from heat sources • Store in non-flammable cabinets
2% Chlorhexidine in Alcohol	• Flammable as it contains alcohol • Contains higher concentration of Chlorhexidine, may cause skin irritation or tingling sensation	• Never use on mucous membranes as it contains alcohol • Keep away from heat sources • Store in non-flammable cabinets • Contra-indicated for those with allergy history of Chlorhexidine
0.05% Aqueous Chlorhexidine Gluconate	• No reported occupational hazard	• None
Peracetic acid (0.2%)	• Concentrated solution is flammable and causes serious eye and skin damage	• Handle in a well-ventilated area • Use appropriate PPE when handling
Sodium hypochlorite (5.25% as in the household bleach)	• Irritates eyes; skin or mucous membranes	• Handle in a well-ventilated area • Use appropriate PPE while handling • Not to be mixed with acids to avoid release of chlorine gas
Citric acid (20-25%)	• Causes serious damage to eyes and skin irritation	• Protective goggle and gloves should be used
Povidone iodine	• May form a yellow or brown stain on skin	• Protective gloves should be used

Remarks:

The table aims at providing general safety information of the substances commonly found in disinfectants. Commercial products usually contain a mixture of different chemicals and thus may have varying chemical properties. The user should observe the Materials Safety Data Sheet (MSDS) of each particular disinfectant for relevant safety information.

In view of the occupational hazard of using formaldehyde, it is desirable for new dialysis centres to use non-formaldehyde based disinfectants to clean the RO system. [63]

10. SURVEILLANCE AND AUDIT

Patients on chronic haemodialysis are at high risk of infections. They have impaired immune systems and require frequent routine puncture of a vascular access site for haemodialysis. For patients on peritoneal dialysis, the leading complication is peritonitis. Severe and prolonged peritonitis may lead to peritoneal membrane failure. Morbidity, mortality and financial burden on the healthcare system are some of the adverse consequences of infections.

Infection is the second most common cause of death in haemodialysis patients in the United States [133] and the leading cause of death in patients receiving renal replacement therapy in Hong Kong. [134] Outbreaks of bacteraemia and blood-borne infections have also been reported in haemodialysis centres. [19, 31, 135, 136]

Resistant organisms may emerge as a result of frequent treatment with antimicrobials. [56, 137, 138] Monitoring antimicrobial use and antimicrobial-resistant organisms related infections in dialysis patients is critical to prevent antimicrobial resistance. [60, 139]

Surveillance of dialysis-associated infections helps to identify risk factors of infections and formulate measures to prevent infection and improve patient safety [42, 139] as well as the quality of healthcare. [139-141]

10.1 Develop specific surveillance programs for dialysis centres. The surveillance program should be incorporated into routine clinical activities and should be regularly conducted to identify blood-borne infections, primary blood stream infections, catheter-associated blood stream infections, peritoneal dialysis related peritonitis, exit site infections, tunnel infections, antibiotic-resistant organisms and antibiotic use. [42, 56, 140-143]

10.2 The quality of water for HD should also be monitored. [42]

10.3 Conduct surveillance in all dialysis centres, including satellite centres and ambulatory care centres. [144-146]

10.4 Each renal unit should regularly audit the compliance of staff to infection control practices such as hand hygiene. [42]

10.5 Use standardised methods and definitions for data collection and analysis. For example, the centre can adopt the surveillance methodology suggested by NHSN of CDC in United States. [147]

10.6 Delegate the surveillance program to trained personnel to ensure that data collection and data management are standardised, timely and accurate. [142, 145]

10.7 Use statistical tool to monitor the trends of infections and identify risk factors of dialysis-related infections. Review causative organisms and presumed aetiology regularly to facilitate intervention if infection is increasing. [68, 147]

10.8 Investigate the cause of exit site infections so that improvements in site care practices can be made accordingly. [3]

10.9 Investigate outbreaks or abnormal clustering of dialysis-related infections and make recommendations to frontline staff as necessary. [144, 148]

10.10 Benchmark the surveillance data with local and international rates, like the Dialysis Surveillance Network (DSN). [147]

10.11 Periodically report the rates and trends of infections to relevant parties.

11. QUALITY MEASURES

11.1 Periodically evaluate and validate the data and process of the surveillance to ensure high quality and accuracy. [142, 147]

11.2 Establish indicators to measure the performance of dialysis centres, [142, 149] such as rates of primary blood stream infections, exit site infections and peritoneal dialysis-related peritonitis.

11.3 Involve multidisciplinary personnel in each dialysis centre to identify areas for improvement and ensure that relevant recommendations, policies and infection control practices have been implemented.

11.4 Regularly review and update evidence-based practices in dialysis.

11.5 All healthcare workers should attend infection control training on a regular basis. [42]

11.6 Develop a well-structured peritoneal dialysis patient training program. The trainer should administer the program, demonstrate procedures and skills of dialysis, care of the catheter and exit site. Refresher training is recommended after peritonitis, catheter infection or interruption in dialysis. [68, 150] This strategy may also be appropriate for haemodialysis patients on home therapy.

APPENDIX A: FREQUENTLY ASKED QUESTIONS (FAQS)

Questions on BBV testing and serology

Q1. For patients with the following serology result: anti-HBc positive, HBsAg negative, should they be classified as HBV infected and dialysed together with HBsAg positive patients?

A1. It would suggest occult hepatitis B infection or past infection. Further testing e.g. HBV DNA may be used to confirm the low level infection. If HBV DNA is positive, the patient should be regarded as HBV infected and dialysed with machines used for HBsAg positive patients; on the contrary, if HBV DNA is negative, without a known history of HBV carrier status, the patient should be regarded as susceptible to hepatitis B and dialysed with machines used for HBsAg negative patients.

Patients with occult hepatitis B infection usually have low and fluctuating levels of HBV DNA viremia. They may be a source of HBV transmission in haemodialysis setting.

Q2. For patients who are anti-HBc positive, HBsAg and HBV DNA negative, how often should HBsAg and HBV DNA be checked?

A2. HBsAg should be checked every 6 months for patients on haemodialysis. The frequency of HBV DNA checking should be individualised, based on consideration of multiple factors (e.g. comorbidities, transplantation, chemotherapy, immunosuppressive therapy and antiviral treatment).

Q3. Is there a need to perform anti-HBc in retrospect for all existing patients on haemodialysis?

A3. Checking anti-HBc prior to haemodialysis is a recommendation in line with overseas guidelines. [1, 10] Unnecessary HBV revaccination or booster vaccinations in patients with occult HBV infection can be avoided.

Q4. Are all serology test results needed before commencing dialysis, even in an urgent setting?

A4. It is preferable to obtain the serology test results prior to the first dialysis session. However, for urgent dialysis, the results may not be available. As long as standard precautions are practiced, the risk of transmission of blood-borne pathogen should be low.

Q5. Does a known HBV carrier who has undergone liver transplant, with negative HBsAg, negative HBV DNA, still require to dialyse with machines used for HBsAg positive patients?

A5. Liver transplant cannot cure HBV infection. The patient will still need to dialyze with HBV machines.

Q6. For patients with anti-HCV positive, HCV RNA negative, should they be dialyzed with machines used for other chronic HCV carriers?

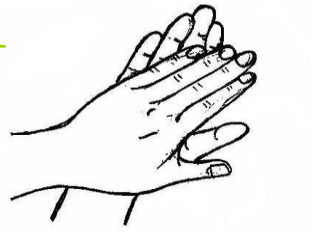
A6. No. The serology result suggests that the patient has been cured of HCV. If using machines for other chronic HCV carrier, it may introduce new HCV infection to the patient.

Q7. Is there a need to check anti-HBe and HBeAg for patients on haemodialysis?

A7. From practical point of view, there is no need to check anti-HBe and HBeAg for haemodialysis. It is mainly for clinical management.

APPENDIX B: HAND HYGIENE TECHNIQUE

1

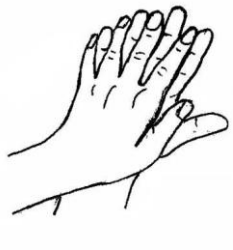


Palm to palm

2

Right palm over left dorsum with interlaced fingers & vice versa

3

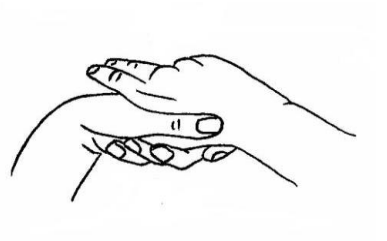


Palm to palm with fingers interlaced

4

Backs of fingers to opposing palm with fingers interlocked

5

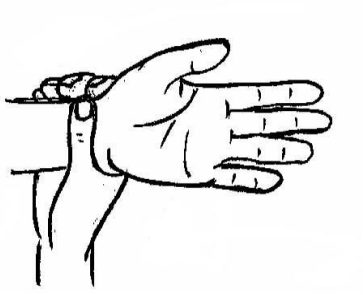


Rotational rubbing of right thumb clasped in left palm & vice versa

6

Rotational rubbing backwards and forwards with clasped fingers of right hand in left palm & vice versa

7



Wrists are rubbed

REFERENCE LIST

1. Department of Health (UK). Good practice guidelines for renal dialysis/transplantation units: Prevention and control of blood-borne virus infection, 2002. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/382207/good_practice_guidelines_renal_dialysis_transplantation.pdf [Accessed on 12 May 2023].

2. Aitken E, Anijeet H, Ashby D, Barrow W, et al. UK Kidney Association Clinical Practice Guideline: Vascular Access for Haemodialysis, 2023. Available from: https://ukkidney.org/sites/renal.org/files/FINAL%20FORMATTED%20Vascular%20access%20for%20haemodialysis%20April%202023.pdf [Accessed on 12 May 2023].

3. O'Grady NP, Alexander M, Burns LA, Dellinger EP, et al. Guidelines for the prevention of intravascular catheter-related infections, 2011 [updated Jul 2017]. Clinical infectious diseases : an official publication of the Infectious Diseases Society of America.52(9); e162-93.

4. Association for Professionals in Infection Control and Epidemiology (APIC). APIC Implementation Guide. Infection Prevention and Control in Dialysis Settings, 2022. Available from: https://apic.org/wp-content/uploads/2022/04/Dialysis_ImplementGuide3.pdf [Accessed on 12 May 2023].

5. Scientific Committee on Infection Control, Department of Health (HK). Recommendations on Prevention of Intravascular Catheter Associated Bloodstream Infection [Version 2.1], 2019. Available from: https://www.chp.gov.hk/files/pdf/recommendations_on_prevention_of_intravascular_catheter_associated_bloodstream_infection.pdf [Accessed on 12 May 2023].

6. Garthwaite E, Reddy V, Douthwaite S, Lines S, et al. Clinical practice guideline management of blood borne viruses within the haemodialysis unit. BMC Nephrology. 2019;20(1); 388.

7. Department of Health, Queensland Government (Australia). Guideline: Haemodialysis catheters, 2015.

8. World Health Organization. Guidelines on hand hygiene in health care, 2009. Available from: https://www.who.int/publications/i/item/9789241597906 [Accessed on 12 May 2023].

9. World Health Organization. WHO policy on TB infection control in health-care facilities, congregate settings and households, 2009. Available from: https://www.who.int/publications/i/item/9789241598323 [Accessed on 12 May 2023].

10. Infection Prevention and Control Canada. Position statement and practice recommendations: Prevention of transmission of Hepatitis B among hemodialysis patients, 2007.

11. Department of Health and Human Services, State of Victoria. Hepatitis B infection control in haemodialysis centres: a Victorian Renal Clinical Network consensus document, 2017. Available from: https://www.health.vic.gov.au/publications/hepatitis-b-infection-control-in-haemodialysis-centres [Accessed on 12 May 2023].

12. Department of Health (UK). Safer practice in renal medicine, 2006.

13. Rutala WA, Weber DJ, and the Healthcare Infection Control Practices Advisory Committee (HICPAC). Guideline for disinfection and sterilization in healthcare facilities, 2008 [updated May 2019]. Available from: https://www.cdc.gov/infectioncontrol/pdf/guidelines/disinfection-guidelines-H.pdf [Accessed on 12 May 2023].

14. Siegel JD, Rhinehart E, Jackson M, Chiarello L. 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Health Care Settings [updated May 2022]. American journal of infection control. 2007;35(10 Suppl 2); S65-164.

15. Siegel JD, Rhinehart E, Jackson M, Chiarello L. Management of multidrug-resistant organisms in health care settings, 2006 [updated Feb 2017]. American journal of infection control. 2007;35(10 Suppl 2); S165-93.

16. Centers for Disease Control and Prevention (US). Infection control requirements for dialysis facilities and clarification regarding guidance on parenteral medication vials. MMWR Morbidity and mortality weekly report. 2008;57(32); 875-6.

17. Scientific Committee on Vaccine Preventable Diseases, Department of Health (HK). Updated recommendations on the use of pneumococcal vaccines for high-risk individuals, 2016, Available from: https://www.chp.gov.hk/files/pdf/updated_recommendations_on_the_use_of_pneumococcal_vaccines_for_high-risk_individuals.pdf [Accessed on 7 July 2023].

18. National Kidney Foundation. KDOQI Clinical Practice Guideline for Hemodialysis Adequacy: 2015 update. American journal of kidney diseases : the official journal of the National Kidney Foundation. 2015;66(5); 884-930.

19. Centers for Disease Control and Prevention (US). Outbreaks of hepatitis B virus infection among hemodialysis patients - California, Nebraska, and Texas, 1994. MMWR Morbidity and mortality weekly report. 1996;45(14); 285-9.

20. Lyerla R, Kellerman S, Alter MJ. Hepatitis B and hemodialysis: the impact of universal precautions in preventing the transmission of bloodborne viruses. Infection control and hospital epidemiology. 1999;20(3); 156-7.

21. Finelli L, Miller JT, Tokars JI, Alter MJ, et al. National surveillance of dialysis-associated diseases in the United States, 2002. Seminars in dialysis. 2005;18(1); 52-61.

22. Hutin YJ, Goldstein ST, Varma JK, O'Dair JB, et al. An outbreak of hospital-acquired hepatitis B virus infection among patients receiving chronic hemodialysis. Infection control and hospital epidemiology. 1999;20(11); 731-5.

23. Alter MJ, Ahtone J, Maynard JE. Hepatitis B virus transmission associated with a multiple-dose vial in a hemodialysis unit. Annals of internal medicine. 1983;99(3); 330-3.

24. Roll M, Norder H, Magnius LO, Grillner L, et al. Nosocomial spread of hepatitis B virus (HBV) in a haemodialysis unit confirmed by HBV DNA sequencing. The Journal of hospital infection. 1995;30(1); 57-63.

25. Kellerman S, Alter MJ. Preventing hepatitis B and hepatitis C virus infections in end-stage renal disease patients: back to basics. Hepatology (Baltimore, Md). 1999;29(1); 291-3.

26. Teles SA, Martins RM, Gomes SA, Gaspar AM, et al. Hepatitis B virus transmission in Brazilian hemodialysis units: serological and molecular follow-up. Journal of medical virology. 2002;68(1); 41-9.

27. Public Health Laboratory Service Survey (UK). Decrease in the incidence of hepatitis in dialysis units associated with prevention programme. British medical journal. 1974;4(5947); 751-4.

28. Fabrizi F, Messa P, Martin P. Hepatitis B Virus Infection and the Dialysis Patient. Seminars in dialysis. 2008;21(5); 440-6.

29. Alavian SM, Bagheri-Lankarani K, Mahdavi-Mazdeh M, Nourozi S. Hepatitis B and C in dialysis units in Iran: changing the epidemiology. Hemodialysis international International Symposium on Home Hemodialysis. 2008;12(3); 378-82.

30. Toma M, Challapalli M. Hepatitis B prevention strategies among pediatric hemodialysis centers. Infection control and hospital epidemiology. 2001;22(2); 113-5.

31. Centers for Disease Control and Prevention (US). Recommendations for preventing transmission of infections among chronic hemodialysis patients [updated 2016]. MMWR Recommendations and reports : Morbidity and mortality weekly report Recommendations and reports. 2001;50(RR05); 1-43.

32. Thompson ND, Novak RT, Datta D, Cotter S, et al. Hepatitis C virus transmission in hemodialysis units: importance of infection control practices and aseptic technique. Infection control and hospital epidemiology. 2009;30(9); 900-3.

33. Okuda K, Hayashi H, Kobayashi S, Irie Y. Mode of hepatitis C infection not associated with blood transfusion among chronic hemodialysis patients. Journal of hepatology. 1995;23(1); 28-31.

34. Savey A, Simon F, Izopet J, Lepoutre A, et al. A large nosocomial outbreak of hepatitis C virus infections at a hemodialysis center. Infection control and hospital epidemiology. 2005;26(9); 752-60.

35. Velandia M, Fridkin SK, Cárdenas V, Boshell J, et al. Transmission of HIV in dialysis centre. Lancet (London, England). 1995;345(8962); 1417-22.

36. El Sayed NM, Gomatos PJ, Beck-Sagué CM, Dietrich U, et al. Epidemic transmission of human immunodeficiency virus in renal dialysis centers in Egypt. The Journal of infectious diseases. 2000;181(1); 91-7.

37. Ho Y-W, Chau K-F, Choy B-Y, Fung K-S, et al. Hong Kong Renal Registry Report 2012. Hong Kong Journal of Nephrology. 2013;15(1); 28-43.

38. Ministry of Health, Singapore. The national infection prevention and control guidelines for outpatient dialysis centres, 2020. Available from: https://www.moh.gov.sg/resources-statistics/guidelines/national-infection-prevention-and-control-guidelines-for-outpatient-dialysis-centres [Accessed on 12 May 2023].

39. Manfredi SR, Canziani ME, Draibe SA, Dalboni MA, et al. A model for improving quality in nephrology settings. Nephrology nursing journal : journal of the American Nephrology Nurses' Association. 2003;30(3); 295-9.

40. CARI Guidelines. Infection control for haemodialysis units, 2018. Available from: https://www.cariguidelines.org/guidelines/dialysis/infection-control-for-haemodialysis-units/infection-control-for-haemodialysis-units/.

41. Ministry of Health, Singapore. Guidelines for private healthcare institutions providing renal dialysis:- Regulation 4 of the private hospitals and medical clinics regulations [CAP 248, Rg 1], 2001. Available from: https://www.moh.gov.sg/docs/librariesprovider5/licensing-terms-and-conditions/guidelines-for-private-healthcare-institutions-providing-renal-dialysis.pdf.

42. Lui SL, Yap D, Cheng V, Chan TM, et al. Clinical practice guidelines for the provision of renal service in Hong Kong: Infection Control in Renal Service. Nephrology (Carlton, Vic). 2019;24 Suppl 1(Suppl 1); 98-129.

43. HA Central Committee on Infectious Disease and Emergency Responses (CCIDER). HA infection control plan (Influenza Pandemic), Jun 2014.

44. Tokars JI. Infections due to antimicrobial-resistant pathogens in the dialysis unit. Blood purification. 2000;18(4); 355-60.

45. Berns JS. Infection with antimicrobial-resistant microorganisms in dialysis patients. Seminars in dialysis. 2003;16(1); 30-7.

46. Centers for Disease Control and Prevention (US). Invasive methicillin-resistant Staphylococcus aureus infections among dialysis patients--United States, 2005. MMWR Morbidity and mortality weekly report. 2007;56(9); 197-9.

47. HA Central Committee on Infectious Disease and Emergency Responses (CCIDER). Guideline on the control of Staphylococcus aureus with reduced susceptibility to Vancomycin, Nov 2022.

48. HA Central Committee on Infectious Disease and Emergency Responses (CCIDER). Guideline on the control of Vancomycin-Resistant Enterococci (VRE), Nov 2019.

49. HA Central Committee on Infectious Disease and Emergency Responses (CCIDER). Guideline on the control of Methicillin-Resistant Staphylococcus aureus (MRSA), Dec 2019.

50. HA Central Committee on Infectious Disease and Emergency Responses (CCIDER). Guideline on infection control for Candida Auris, May 2021.

51. Agar JW. Home hemodialysis in Australia and New Zealand: practical problems and solutions. Hemodialysis international International Symposium on Home Hemodialysis. 2008;12 Suppl 1; S26-32.

52. National Health Service (NHS). Guideline for interdisciplinary care and maintenance of long-term central venous catheters, in patients with cancer, 2013.

53. Centre for Health Protection. Notification & death rate of tuberculosis (all forms), 1947 - 2022. Available from: https://www.chp.gov.hk/en/statistics/data/10/26/43/88.html [Accessed on 7 July 2023]

54. HA Central Committee on Infectious Disease and Emergency Responses (CCIDER). Control of transmission of Tuberculosis in the healthcare settings, Nov 2017.

55. National Institute of Diabetes and Digestive and Kidney Diseases. NIH Publication No. 14-4554. Vascular access for hemodialysis [Brochures], 2014.

56. Tokars JI, Miller ER, Stein G. New national surveillance system for

hemodialysis-associated infections: initial results. American journal of infection control. 2002;30(5); 288-95.

57. Dinwiddie LC. Managing catheter dysfunction for better patient outcomes: a team approach. Nephrology nursing journal : journal of the American Nephrology Nurses' Association. 2004;31(6); 653-60, 71; quiz 61-2.

58. Kline AM. Pediatric catheter-related bloodstream infections: latest strategies to decrease risk. AACN clinical issues. 2005;16(2); 185-98; quiz 272-4.

59. Jung JY, Yoo KD, Kang E, Kang HG, et al. Korean Society of Nephrology 2021 Clinical Practice Guideline for Optimal Hemodialysis Treatment. Kidney research and clinical practice. 2021;40(Suppl 1); S1-s37.

60. Nguyen DB, Shugart A, Lines C, Shah AB, et al. National Healthcare Safety Network (NHSN) Dialysis Event Surveillance Report for 2014. Clinical journal of the American Society of Nephrology : CJASN. 2017;12(7); 1139-46.

61. Centers for Disease Control and Prevention (US). 2014-2019 Surveillance summary of bloodstream infections in outpatient hemodialysis facilities - National Healthcare Safety Network. Available from: https://www.cdc.gov/dialysis/pdfs/BSI-NHSN-2014to2019-508.pdf [Accessed on 27 July 2023].

62. Tordoir J, Canaud B, Haage P, Konner K, et al. EBPG on Vascular Access. Nephrology, dialysis, transplantation : official publication of the European Dialysis and Transplant Association - European Renal Association. 2007;22 Suppl 2; ii88-117.

63. Working Group on Quality Assurance in Renal Services. Quality initiative recommendation in the provision of renal services, 2002. Hong Kong College of Physicians and Central Renal Committee (Hospital Authority). Available from: http://www.hkcp.org/docs/TrainingGuidelines/renal_services.pdf [Accessed on 12 May 2023].

64. Dixon BS. Choice and Maintenance of the Vascular Access. In: Wilcox CS, editor. Therapy in Nephrology and Hypertension: A Companion to Brenner & Rector's The Kidney. Third Edition ed: Elsevier; 2008. p. 859-74.

65. Ponikvar R, Buturović-Ponikvar J. Temporary hemodialysis catheters as a long-term vascular access in chronic hemodialysis patients. Therapeutic apheresis and dialysis : official peer-reviewed journal of the International Society for Apheresis, the Japanese Society for Apheresis, the Japanese Society for Dialysis Therapy. 2005;9(3); 250-3.

66. Institue for Healthcare Improvement. How-to Guide: Prevent Central Line-Associated Bloodstream Infection, Cambridge, Massachusetts, USA. Cambridge, Massachusetts, USA; 2012.

67. Buetti N, Marschall J, Drees M, Fakih MG, et al. Strategies to prevent central line-associated bloodstream infections in acute-care hospitals: 2022 Update. Infection control and hospital epidemiology. 2022;43(5); 553-69.

68. Flanigan M, Gokal R. Peritoneal Catheters and Exit-Site Practices toward Optimum Peritoneal Access: A Review of Current Developments. Peritoneal Dialysis International. 2005;25(2); 132-9.

69. Li PK-T, Chow KM, Cho Y, Fan S, et al. ISPD peritonitis guideline recommendations: 2022 update on prevention and treatment. Peritoneal Dialysis International. 2022;42(2); 110-53.

70. Chow KM, Li PK-T, Cho Y, Abu-Alfa A, et al. ISPD Catheter-related Infection Recommendations: 2023 Update. Peritoneal Dialysis International. 2023;43(3); 201-19.

71. Elamin S, Abu-Aisha H. Prevention of hepatitis B virus and hepatitis C virus transmission in hemodialysis centers: review of current international recommendations. Arab journal of nephrology and transplantation. 2011;4(1); 35-47.

72. World Health Organization. Guidelines for the prevention, care and treatment of persons with chronic hepatitis B infection, 2015. Available from: https://www.who.int/publications/i/item/9789241549059 [Accessed on 19 July 2023].

73. Centers for Disease Control and Prevention (US). Testing for HCV infection: an update of guidance for clinicians and laboratorians. MMWR Morbidity and mortality weekly report. 2013;62(18); 362-5.

74. Centers for Disease Control and Prevention (US). Interpretation of

hepatitis B serologic test results. Available from: https://www.cdc.gov/hepatitis/hbv/interpretationOfHepBSerologicResults.htm [Accessed on 19 July 2023]

75. Scientific Working Group on Viral Hepatitis Prevention, Department of Health (HK). Recommendations on Hepatitis B vaccination regimens in Hong Kong, 2004. Available from: https://www.hepatitis.gov.hk/english/health_professionals/files/a_hepbreg04.pdf [Accessed on 12 May 2023].

76. Hung IF, Yap DY, Yip TP, Zhang RR, et al. A Double-blind, Randomized Phase 2 Controlled Trial of Intradermal Hepatitis B Vaccination With a Topical Toll-like Receptor 7 Agonist Imiquimod, in Patients on Dialysis. Clinical infectious diseases : an official publication of the Infectious Diseases Society of America. 2021;73(2); e304-e11.

77. Mast EE, Weinbaum CM, Fiore AE, Alter MJ, et al. A comprehensive immunization strategy to eliminate transmission of hepatitis B virus infection in the United States: recommendations of the Advisory Committee on Immunization Practices (ACIP) Part II: immunization of adults. MMWR Recommendations and reports : Morbidity and mortality weekly report Recommendations and reports. 2006;55(Rr-16); 1-33; quiz CE1-4.

78. World Health Organization. Estimating disease burden of influenza. Available from: https://www.who.int/europe/activities/estimating-disease-burden-of-influenza [Accessed on 7 July 2023]

79. Wu P, Presanis AM, Bond HS, Lau EHY, et al. A joint analysis of influenza-associated hospitalizations and mortality in Hong Kong, 1998-2013. Scientific reports. 2017;7(1); 929.

80. Scientific Committee on Vaccine Preventable Diseases, Department of Health (HK). Recommendations on seasonal influenza vaccination for the 2023/24 season in Hong Kong, Apr 2023. Available from: https://www.chp.gov.hk/files/pdf/recommendations_on_seasonal_influenza_vaccination_for_the_2023_24_season_in_hong_kong_19apr.pdf [Accessed on 7 July 2023].

81. Ma BM, Yap DYH, Yip TPS, Hung IFN, et al. Vaccination in patients with chronic kidney disease-Review of current recommendations and recent

advances. Nephrology (Carlton, Vic). 2021;26(1); 5-11.

82. World Health Organization. Vaccines against influenza: WHO position paper - May 2022. Weekly Epidemiological Record.19(97); 185-208.

83. World Health Organization, Regional Office for the Western, Pacific. Practical guidelines for infection control in health care facilities: WHO Regional Office for the Western Pacific; 2004.

84. Government of Canada. Flu (influenza): For health professionals. Available from: https://www.canada.ca/en/public-health/services/diseases/flu-influenza/health-professionals.html [Accessed on 7 July 2023]

85. Centers for Disease Control and Prevention (US). Prevention strategies for seasonal influenza in healthcare settings. Available from: https://www.cdc.gov/flu/professionals/infectioncontrol/healthcaresettings.htm [Accessed on 7 July 2023]

86. Centers for Disease Control and Prevention (US). Pneumococcal Disease. Clinical Features. Available from: https://www.cdc.gov/pneumococcal/clinicians/clinical-features.html [Accessed on 7 July 2023]

87. Huang ST, Lin CL, Chang YJ, Sher YP, et al. Pneumococcal pneumonia infection is associated with end-stage renal disease in adult hospitalized patients. Kidney international. 2014;86(5); 1023-30.

88. Kobayashi M, Farrar JL, Gierke R, Britton A, et al. Use of 15-Valent Pneumococcal Conjugate Vaccine and 20-Valent Pneumococcal Conjugate Vaccine Among U.S. Adults: Updated Recommendations of the Advisory Committee on Immunization Practices - United States, 2022. MMWR Morbidity and mortality weekly report. 2022;71(4); 109-17.

89. Scientific Committee on Vaccine Preventable Diseases, Department of Health (HK). Recommendations on the use of 15-valent Pneumococcal Conjugate Vaccine (PCV15) and 20-valent Pneumococcal Conjugate Vaccine (PCV20) in Hong Kong (As of 27 September 2023), Available from: https://www.chp.gov.hk/files/pdf/recommendations_on_the_use_of_15valent_pneumococcal_conjugate_vaccine_and_20valent_pneumococcal_conjugate_vaccine_in_hong_kong_27sep.pdf [Accessed on 27 October 2023].

90. Centers for Disease Control and Prevention (US). Pneumococcal Vaccination: Summary of Who and When to Vaccinate. Available from: https://www.cdc.gov/vaccines/vpd/pneumo/hcp/who-when-to-vaccinate.html [Accessed on 6 November 2023]

91. Scientific Committee on Emerging and Zoonotic Disease and Scientific Committee on Vaccine Prevnetable Diseases (HK). Consensus interim recommendations on the use of COVID-19 vaccines in Hong Kong (As of Jan 7, 2021). Available from: https://www.chp.gov.hk/files/pdf/consensus_interim_recommendations_on_the_use_of_covid19_vaccines_inhk.pdf [Accessed on 7 July 2023].

92. Scientific Committee on Emerging and Zoonotic Disease and Scientific Committee on Vaccine Prevnetable Diseases (HK). Consensus interim recommendations on the use of COVID-19 vaccines in Hong Kong (As of 29 March 2023). Available from: https://www.chp.gov.hk/files/pdf/consensus_interim_recommendations_on_the_use_of_covid19_vaccines_in_hong_kong_29mar.pdf [Accessed on 7 July 2023].

93. Centers for Disease Control and Prevention (US). Guidelines for Environmental Infection Control in Health-Care Facilities: Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC) [updated Jul 2019], 2003. Available from: https://www.cdc.gov/infectioncontrol/pdf/guidelines/environmental-guidelines-P.pdf [Accessed on 12 May 2023].

94. The American Institute of Architects. Guidelines for Design and Construction of Health Care Facilities. Washington: AIA; 2006.

95. NHS England. Health Buiding Note 07-02: Main renal unit: planning and design, Available from: https://www.england.nhs.uk/publication/main-renal-unit-planning-and-design-hbn-07-02/ [Accessed on 31 July 2023].

96. Centers for Disease Control and Prevention (US). Environmental surface disinfection in dialysis facilities: Notes for clinical managers, Available from: https://www.cdc.gov/dialysis/PDFs/collaborative/Env_notes_Feb13.pdf [Accessed on 20 July 2023].

97. U.S. Environmental Protection Agency (EPA). Selected EPA-registered disinfectants. Available from: https://www.epa.gov/pesticide-registration/selected-epa-registered-disinfectants [Accessed on 20 July 2023]

98. Association for the Advancement of Medical Instrumentation. Dialysate for hemodialysis: ANSI/AAMI RD 52, Arlington, Va. Association for the Advancement of Medical Instrumentation; 2004.

99. Agency for Clinical Innovation. Water for dialysis: A guide for in-centre, satellite and home haemodialysis in NSW, ACI Renal Network; 2018. Available from: https://aci.health.nsw.gov.au/__data/assets/pdf_file/0007/306088/ACI-Water-dialysis.pdf [Accessed on 12 May 2023].

100. Association for the Advancement of Medical Instrumentation. Guidance for the preparation and quality management of fluids for hemodialysis and related therapies: ANSI/AAMI/ISO 23500:2019, Arlington, Va. Association for the Advancement of Medical Instrumentation; 2019.

101. Prevention of Legionnaires' Disease Committee, Hong Kong. Code of Practice for Prevention of Legionnaires' Disease, 2021 Edition.

102. Association for the Advancement of Medical Instrumentation. Guidance for the preparation and quality management of fluids for hemodialysis and related therapies: ANSI/AAMI 23500:2014, Arlington, Va. Association for the Advancement of Medical Instrumentation; 2014.

103. Ward RA. Worldwide water standards for hemodialysis. Hemodialysis International. 2007;11(s1); S18-S25.

104. Cheng YL, Tang HL, Tong MKL. Clinical practice guidelines for the provision of renal service in Hong Kong: Haemodialysis. Nephrology (Carlton, Vic). 2019;24 Suppl 1; 41-59.

105. Association for the Advancement of Medical Instrumentation. Water for hemodialysis and related therapies: ANSI/AAMI 13959:2014, Arlington, Va. Association for the Advancement of Medical Instrumentation; 2014.

106. Kong I, Law MC, Ng GS. Clinical practice guidelines for the provision of renal service in Hong Kong: Renal Nursing Practice. Nephrology (Carlton, Vic).

2019;24 Suppl 1; 77-97.

107. Duerden BI, Reid TMS, Jewsbury JM, Turk DC. A new short textbook of microbial and parasitic infection. 1987.

108. Northwest Renal Network. Monitoring your dialysis water treatment system, 2005. Available from: https://www.serim.com/docs/WaterManual.pdf [Accessed on 12 May 2023].

109. SA Health, Government of South Australia. South Australian Clinical Practice Guideline. Haemodialysis: Routine Water Testing and Reverse Osmosis Monitoring, 2022. Available from: https://www.sahealth.sa.gov.au/wps/wcm/connect/bd096e004a4622f78af7cfb0cfc4074a/Haemodialysis_Routine+Water+Testing+and+Reverse+Osmosis+Monitoring_V3_1.pdf?MOD=AJPERES&CACHEID=ROOTWORKSPACE-bd096e004a4622f78af7cfb0cfc4074a-otUQpZz.

110. BC Renal Agency. Clinical Practice Standards and Procedures for Dialysis Water Quality: 1b: Microbial Testing of Dialysis Water, 2011. Available from: http://www.bcrenal.ca/resource-gallery/documents/1bmicrobial-testing-of-dialysis-water-final_2013.pdf.

111. NHS England and NHS Improvement. Uniforms and workwear: guidance for NHS employers, 2020. Available from: https://www.england.nhs.uk/coronavirus/documents/uniforms-and-workwear-guidance-for-nhs-employers/ [Accessed on 12 May 2023].

112. Gordon CE, Balk EM, Becker BN, Crooks PA, et al. KDOQI US commentary on the KDIGO clinical practice guideline for the prevention, diagnosis, evaluation, and treatment of hepatitis C in CKD. American journal of kidney diseases : the official journal of the National Kidney Foundation. 2008;52(5); 811-25.

113. Infection Control Branch, Centre for Health Protection, Department of Health and Central Committee on Infectious Diseases, Hospital Authority. ICB Infection Control Guidelines: Enviormental Control (Advanced Draft), 2007. Available from: https://www.chp.gov.hk/files/pdf/environmental_decontamination.pdf [Accessed on 12 May 2023].

114. Environmental Protection Department (HK). Code of Practice for the Management of Clinical Waste - Major Clinical Waste Producers and Waste Collectors, 2010. Available from: https://www.epd.gov.hk/epd/clinicalwaste/file/doc07_en.pdf [Accessed on 12 May 2023].

115. Blagg CR. It's time to look at home hemodialysis in a new light. AAMI: Hemodialysis Horizons. 2006; 22-8.

116. Hawley CM, Jeffries J, Nearhos J, Van Eps C. Complications of home hemodialysis. Hemodialysis international International Symposium on Home Hemodialysis. 2008;12 Suppl 1; S21-5.

117. Pipkin M, Craft V, Spencer M, Lockridge Jr. RS. Six years of experience with nightly home hemodialysis access. Hemodialysis International. 2004;8(4); 349-53.

118. Masterson R. The advantages and disadvantages of home hemodialysis. Hemodialysis international International Symposium on Home Hemodialysis. 2008;12 Suppl 1; S16-20.

119. Kerr PG, Polkinghorne KR, McDonald SP. Home hemodialysis in Australia: current perspective. Hemodialysis international International Symposium on Home Hemodialysis. 2008;12 Suppl 1; S6-10.

120. Honkanen EO, Rauta VM. What happened in Finland to increase home hemodialysis? Hemodialysis international International Symposium on Home Hemodialysis. 2008;12 Suppl 1; S11-5.

121. Nesrallah GE, Cuerden M, Wong JH, Pierratos A. Staphylococcus aureus bacteremia and buttonhole cannulation: long-term safety and efficacy of mupirocin prophylaxis. Clinical journal of the American Society of Nephrology : CJASN. 2010;5(6); 1047-53.

122. Piccoli GB, Bermond F, Mezza E, Burdese M, et al. Vascular access survival and morbidity on daily dialysis: a comparative analysis of home and limited care haemodialysis. Nephrology, dialysis, transplantation : official publication of the European Dialysis and Transplant Association - European Renal Association. 2004;19(8); 2084-94.

123. Centers for Disease Control and Prevention (US). Infection control for

peritoneal dialysis (PD) patients after a disaster 2005. Available from: https://www.cdc.gov/disasters/icfordialysis.html [Accessed on 12 May 2023]

124. Frankel AH, Cassidy MJ. Pasteurella multocida peritonitis in CAPD: beware of the cats. Peritoneal dialysis international : journal of the International Society for Peritoneal Dialysis. 1991;11(2); 184-5.

125. Rondon-Berrios H, Trevejo-Nunez GJ. Pets or Pest: Peritoneal Dialysis-related Peritonitis due to Pasteurella multocida. Journal of Microbiology, Immunology and Infection. 2010;43(2); 155-8.

126. Castellano I, Marín JP, Gallego S, Mora M, et al. Pasteurella canis peritonitis in a peritoneal dialysis patient. Peritoneal dialysis international : journal of the International Society for Peritoneal Dialysis. 2011;31(4); 503-4.

127. Cooke FJ, Kodjo A, Clutterbuck EJ, Bamford KB. A case of Pasteurella multocida peritoneal dialysis-associated peritonitis and review of the literature. International journal of infectious diseases : IJID : official publication of the International Society for Infectious Diseases. 2004;8(3); 171-4.

128. Broughton A, Verger C, Goffin E. Pets-related peritonitis in peritoneal dialysis: companion animals or trojan horses? Seminars in dialysis. 2010;23(3); 306-16.

129. Chow KM, Pang WF, Szeto CC, Li PK. Playing cat and mouse with a gram-negative organism causing peritonitis. Peritoneal dialysis international : journal of the International Society for Peritoneal Dialysis. 2010;30(6); 662-3.

130. Centers for Disease Control and Prevention (US). Exposure to blood; what healthcare personnel need to know. 2003. Available from: https://stacks.cdc.gov/view/cdc/6853 [Accessed on 12 May 2023]

131. Centers for Disease Control and Prevention (US). National Institute for Occupational Safety and Health (NIOSH) Publication No. 2000-108: Preventing Needlestick Injuries in Health Care Settings, 1999. Available from: https://www.cdc.gov/niosh/docs/2000-108/default.html [Accessed on 26 July 2023].

132. Centers for Disease Control and Prevention (US). Updated U.S. Public Health Service Guidelines for the Management of Occupational Exposures to HBV, HCV, and HIV and Recommendations for Postexposure Prophylaxis.

MMWR Recommendations and reports : Morbidity and mortality weekly report Recommendations and reports. 2001;50(RR-11); 1-52.

133. Jeon Y, Kim HD, Hong YA, Kim HW, et al. Clinical outcomes of infection-related hospitalization in incident peritoneal dialysis patients. Kidney research and clinical practice. 2020;39(4); 460-8.

134. Ho YW, Chau KF, Leung CB, Choy BY, et al. Hong Kong Registry Report 2004. Hong Kong Journal of Nephrology. 2005;7(1); 38-46.

135. Wang SA, Levine RB, Carson LA, Arduino MJ, et al. An outbreak of gram-negative bacteremia in hemodialysis patients traced to hemodialysis machine waste drain ports. Infection control and hospital epidemiology. 1999;20(11); 746-51.

136. Spada E, Abbate I, Sicurezza E, Mariano A, et al. Molecular epidemiology of a hepatitis C virus outbreak in a hemodialysis unit in Italy. Journal of medical virology. 2008;80(2); 261-7.

137. Atta MG, Eustace JA, Song X, Perl TM, et al. Outpatient vancomycin use and vancomycin-resistant enterococcal colonization in maintenance dialysis patients. Kidney international. 2001;59(2); 718-24.

138. Pop-Vicas A, Strom J, Stanley K, D'Agata EM. Multidrug-resistant gram-negative bacteria among patients who require chronic hemodialysis. Clinical journal of the American Society of Nephrology : CJASN. 2008;3(3); 752-8.

139. Hasanoglu I, Guner R, Sahin S, Yılmaz Karadag F, et al. Surveillance of hemodialysis related infections: a prospective multicenter study. Scientific reports. 2022;12(1); 22240.

140. George A, Tokars JI, Clutterbuck EJ, Bamford KB, et al. Reducing dialysis associated bacteraemia, and recommendations for surveillance in the United Kingdom: prospective study. BMJ (Clinical research ed). 2006;332(7555); 1435.

141. Ansell D, Roderick P, Hodsman A, Ford D, et al. UK Renal Registry 11th Annual Report (December 2008): Chapter 7 Survival and causes of death of UK adult patients on renal replacement therapy in 2007: national and centre-specific analyses. Nephron Clinical practice. 2009;111 Suppl 1; c113-39.

142. Ho YW, Leung CB, Choy BY, Fung KS, et al. Renal registry and peritoneal dialysis management: the Hong Kong perspective. Peritoneal dialysis international : journal of the International Society for Peritoneal Dialysis. 2008;28 Suppl 3; S12-4.

143. Dopirak M, Hill C, Oleksiw M, Dumigan D, et al. Surveillance of hemodialysis-associated primary bloodstream infections: the experience of ten hospital-based centers. Infection control and hospital epidemiology. 2002;23(12); 721-4.

144. Dhingra RK, Young EW, Hulbert-Shearon TE, Leavey SF, et al. Type of vascular access and mortality in U.S. hemodialysis patients. Kidney international. 2001;60(4); 1443-51.

145. Department of Health, Government of Western Australia. Healthcare Infection Surveillance of Western Australia (HISWA). [Version 7], 2020. Available from: https://www.health.wa.gov.au/-/media/Files/Corporate/general-documents/Infectious-diseases/PDF/HISWA/healthcare-infection-surveillance-manual.pdf [Accessed on 7 July 2023].

146. Taylor G, Gravel D, Johnston L, Embil J, et al. Prospective surveillance for primary bloodstream infections occurring in Canadian hemodialysis units. Infection control and hospital epidemiology. 2002;23(12); 716-20.

147. Centers for Disease Control and Prevention (US). National healthcare safety network (NHSN) - Dialysis event surveillance protocol, 2023. Available from: https://www.cdc.gov/nhsn/pdfs/pscmanual/8pscdialysiseventcurrent.pdf [Accessed on 7 July 2023].

148. Hannah EL, Stevenson KB, Lowder CA, Adcox MJ, et al. Outbreak of hemodialysis vascular access site infections related to malfunctioning permanent tunneled catheters: making the case for active infection surveillance. Infection control and hospital epidemiology. 2002;23(9); 538-41.

149. The Australian Council on Healthcare Standards. ACHS 2022 Clinical Indicator Program Information, Ultimo, N.S.W., Australia. Australian Council on Healthcare Standards; 2022. Available from: https://www.achs.org.au/getmedia/e2b78142-55dd-4204-8b34-620d3c87e233/achs_2021_clinical_indicator_program_information_march.pdf [Accessed on 12

May 2023].

150. Bernardini J, Price V, Figueiredo A. Peritoneal Dialysis Patient Training, 2006. Peritoneal Dialysis International. 2006;26(6); 625-32.

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