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Clinical Practice Guidelines for the Provision of Renal Services in Hong Kong

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The Hong Kong Clinical Practice Guideline for Nephrology is jointly published by the Hong Kong College of Physicians and the Central Renal Committee of Hospital Authority of Hong Kong with the support from the Hong Kong Society of Nephrology. The publication of this Guideline as a Supplement in *Nephrology* is jointly funded by the Hong Kong College of Physicians and the Hong Kong Society of Nephrology

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SUPPLEMENT ARTICLES

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Foreword

It gives me great pleasure to provide a foreword for the 'Clinical Practice Guidelines in Renal Services of Hong Kong' to express my appreciation to the concerted effort of the Hong Kong College of Physicians (HKCP) and the Central Renal Committee (CRC) of the Hospital Authority.

The irresistible pursue of health-care professionalism by the public has always encouraged the health-care profession to strive as highly as a quality it defines. To achieve this ever-thriving standard of quality by the public, quality assurance is the basis on which the health-care profession pledges its responsibility to the public.

'The Quality Initiative Recommendation in the Provision of Renal Services' was published over 15 years ago. Since then, it has been widely adopted by nephrologists, renal nurses and health professionals as standard guidelines in assuring the provision of quality renal services. Nevertheless, with the emerging new evidence, it is high time to publish a set of clinical practice guidelines that can assist practitioner and patient decisions on appropriate health care for renal conditions.

With the joint efforts of nephrologists and renal nurses in the public and private sectors, the HKCP, CRC and the Hong Kong Society of Nephrology have now compiled the 'Clinical Practice Guidelines in Renal Services of Hong Kong' to serve as the standard and guidelines in the field, covering various aspects, including general nephrology, haemodialysis, renal nursing, infection control, transplantation, and so on.

Optimizing the use of the established clinical practice guidelines is crucial not just for individual health but also for public health as it is our second step in the right direction in the renal service. Being the 'standards' bearers, the collaboration and the acceptance of the nephrologists, renal nurses and health professionals in both public and private sectors is the most essential to make this supplement bear favourably to every renal service users.

As the Secretary for Food and Health, I would like to invite all health-care professions to help complete the reform in the quality assurance of the renal service.

Professor Sophia Siu-Chee Chan
Secretary for Food and Health
Food and Health Bureau, The Government of the Hong Kong Special Administrative Region

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Foreword

Ever since I became the Chairman of the Hospital Authority, I have always been advised that the Renal Services is a model of steadily progressing branch of medicine being run by a group of hard-working and closely knitted health care workers. Having personally witnessed and participated in the well-coordinated and well attended public functions such as the Renal Patients Sports Day and the World Kidney Day organized by these colleagues, I am pleased to see that they are equally adept in the publication of the Clinical Practice Guidelines in Renal Services as a culmination of work by our dedicated experts in the various branches of renal care.

Renal disease now accounts for a huge workload of any health care system, and the statistics that around 10% of the population suffers from some form of chronic kidney disease is alarming for any health care administrators. Moreover, we are now well aware of the prohibitive cost of any renal replacement therapy, and the ever-increasing cost of the advancing medical technologies. Cost-effective use of limited resources in the best interests of patient's care is now the challenge we face in our daily practice.

With the increasing demands from our patients, the escalating costs of health care, and the increasing complexity of medicine, it is indeed timely that we should have a set of local guidelines for our Renal Services.

From my perspective, the most pleasing aspect of this book is that it is the work of such a wide cross section of our renal community. The fact that physicians from both the private and public sectors, nurses, microbiologists, academics, doubling as representatives from the Hong Kong College of Physicians, the Hong Kong Society of Nephrology, and the Hospital Authority; can all come together to complete this book is a testament of the commitment of all concerned to have a set of common guidelines for Hong Kong.

Lastly, I must congratulate Professor Richard Yu for his vision in promoting the idea, and the editors and the authors for their hard work. I trust that the book will become a precious reference to all health care workers in the practice of renal medicine, and ultimately it will lead to improved and more standardized care for all patients.

Professor John Chi-Yan Leong
Chairman
Hospital Authority, Hong Kong

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Foreword

It has been 15 years in 2002 since the publication of Quality Initiative Recommendation in the Provision of Renal Services and Accreditation of Renal Dialysis Unit on Guideline to ensure standard criteria for institution and dialysis centres in both public and private sector.

In these intertwining 15 years, we witnessed rapid advances in technology in clinical management of patients with renal disease and renal replacement therapy. The Hong Kong College of Physicians once again in collaboration with the Central Renal Committee of the Hospital Authority, The Hong Kong Society Nephrology and Renal Nursing Subcommittee have undertaken this mammoth task in compiling the "Clinical Practice Guideline for Renal Services of Hong Kong".

Renal replacement therapy – Haemodialysis, Peritoneal Dialysis and Transplantation - Renal Nursing, Infection Control, General Nephrology and Accreditation of Renal Dialysis have all been updated to international standard and requirement.

Of particular importance is more stringent criteria in Infection Control for patients and healthcare provider with emphasis on the management and prevention of blood borne viral infection, and in quality and purity of water treatment system. Accreditation of Renal Dialysis Units require more stringent standard to provide the Department of Health in licensing of dialysis units in both public and private sectors as there is a proliferation of private facilities. In haemodialysis there is a new paradigm approach with the introduction of home nocturnal dialysis.

The need to update the guideline is to ensure the safety standard and well being of not only for the patients but the healthcare provider.

Professor Richard Yu
Senior Advisor
Hong Kong College of Physicians and
Hong Kong Society of Nephrology

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Preface

It is indeed my great pleasure to see the publication of the Clinical Practice Guidelines for renal service in Hong Kong. It is the joint effort of the Hong Kong College of Physicians and the Central Renal Committee of Hospital Authority and supported by the Hong Kong Society of Nephrology.

It has been the efforts of the Hong Kong renal community from both nephrologists and renal nurses with other specialists which has spanned for the last 2 years. The preparation of the guidelines have gone through a very elaborate process, which was open and transparent. We have conducted an open forum for all stakeholders from the public and private sector to present to them our drafts and to listen to their comments. After further revision, the final draft has been put in the website of the Hong Kong College of Physicians inviting comments and suggestions before we finalise the documents.

Renal medicine is fast advancing and it is important that the quality of care of renal patients and the standards of dialysis units, both peritoneal dialysis and hemodialysis, to be well maintained. This guidelines are very important and have been used as standards for accreditation of the Renal Units in Hong Kong.

As the President of Hong Kong College of Physicians, I am particularly happy that such guidelines are published jointly with the Hospital Authority and the Hong Kong Society of Nephrology. That is one of the ways to upkeep our professionalism. I hope that other specialties can follow and the College is very forthcoming to support.

As Chairman of Central Renal Committee of Hospital Authority, I am grateful to our nephrologists and renal nurses for their hard work to maintain a high quality of care of our renal patients in Hong Kong. The publication of these guidelines reflect the high standards that we can achieve in Hong Kong.

I am particularly pleased that these guidelines are published in *Nephrology*, the official Journal of the Asian Society of Nephrology, of which I am now the President. Not only this shows the support of Hong Kong for the Asian Pacific nephrology, it also allows our guidelines to be available in an indexed journal readily searchable from the web.

Once again, I thank all the Editors and the Authors for the contributions to the success of publication of these guidelines.

Last but not least, I would like to thank Prof Sophia Chan, Secretary for Food and Health, Prof John Leong, Chairman of Hospital Authority and Prof Richard Yu, Senior Advisor to the Hong Kong College of Physicians and the Hong Kong Society of Nephrology for their invaluable advice and support.

Professor Philip Kam-Tao Li
President
Hong Kong College of Physicians,
Chairman,
Central Renal Committee,
Hospital Authority, Hong Kong

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Preface

Hong Kong published its first set of guidelines in the delivery of renal service, the Quality Initiative Recommendation in the Provision of Renal Services, in 2002. The Clinical Practice Guidelines for Renal Service in Hong Kong in this special issue of *Nephrology* is regarded as the new edition of these guidelines. It is revised under the auspices of the Hong Kong College of Physicians and the Central Renal Committee, Hospital Authority, and with the support from the Hong Kong Society of Nephrology.

The Hong Kong Society of Nephrology was founded in 1979. It is a non-profit-making professional organization consisting of doctors, nurses and other allied health staff who are interested in renal diseases. One of main objectives of the Society is to improve the standard of nephrology care in Hong Kong, and the Society has been played a very active role in the establishment of post-graduate nephrology training. Moreover, the Society has also worked closely with the Central Renal Committee of Hospital Authority, the Hong Kong College of Physicians and many other local and international professional bodies in organizing renal educational programmes. As the Chairman of the Hong Kong Society of Nephrology, I am very pleased that the experts in Hong Kong have combined their efforts again to revise the guidelines for general nephrology, renal replacement therapies, renal nursing, infection control and accreditation of renal dialysis unit, and data entry for renal registry.

In recent decades, there have been significant developments in nephrology with medical and technological advances in pharmacology and dialysis technology. Moreover, Hong Kong also experiences changes in the service model in the delivery of renal service, for instance, the introduction of home haemodialysis in 2006. All these improve clinical outcomes and quality of life in patients with chronic kidney disease. In this issue, the content has been revised, new topics are added and the guidelines are updated and evidence-based. The publication will serve as a useful reference for the renal community and other medical personnel, and it will provide guidelines to ensure the standard of the renal services in Hong Kong.

On behalf of the Hong Kong Society of Nephrology, I would like to thank the extraordinary efforts of the editors, the authors and the whole renal community who contributed to this issue of *Nephrology*. I would also like to acknowledge the profound contributions of the Hong Kong College of Physicians and the Central Renal Committee of Hospital Authority. Finally I would like to thank Professor Philip Li for his great leadership and our senior advisor Professor Richard Yu for his unflagging support.

Dr Yuk-Lun Cheng
Chairman
Hong Kong Society of Nephrology

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Preface

In 2015, the Hong Kong College of Physicians and the Central Renal Committee of Hong Kong Hospital Authority envisioned the need to publish an updated set of clinical practice guideline for renal service in Hong Kong. With the support from the Hong Kong Society of Nephrology, this was quickly followed by the identification of experts in each sub-specialty area. The first draft of the guideline was crafted in 2017 and an open forum, which saw a full-house turnout at the Hospital Authority's auditorium, was held on 2 July 2017. Comments and suggestions from all stakeholders were gathered, and the chapter on each sub-specialty area was modified and updated accordingly. A second round of open consultation by email circulation was conducted in early 2018. Further opinions were gathered and updates executed.

We would therefore like to take this opportunity to extend our gratitude to all the contributors for making this contemporary clinical practice guideline possible, and to all stakeholders who gave valuable comments to sharpen the quality of this guideline. We hope this clinical practice guideline will aid the implementation of renal service not only in Hong Kong, but also serve as a reference for many countries around the world.

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Supplement Article

Clinical practice guidelines for the provision of renal service in Hong Kong: General Nephrology

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A. ACUTE KIDNEY INJURY

About one-third of the acute kidney injury (AKI) burden occurs in the perioperative context, and the incidence of AKI continues to rise. While mortality rates in AKI have improved, the figures remain significant. Crucial factors that determine the prognosis include timing of onset, severity and duration of injury, recovery status and recurrence. AKI is associated with an increased hospital mortality, risk of hospital readmissions and risk of chronic kidney disease (CKD).

1. Definition and Staging

- AKI is defined as any of (Not Graded):
  - Increase in serum creatinine (SCr) by ≥26.5 μmol/L within 48 h; or
  - Increase in SCr to ≥1.5 times baseline within the prior 7 days; or
  - Urine volume < 0.5 mL/kg/h for 6 h.
  - AKI is staged for severity according to (Not Graded):

Stage	SCr	Urine output
1	1.5–1.9 times baseline OR ≥26.5 μmol/L increase	<0.5 mL/kg/h for 6–12 h
2	2.0–2.9 times baseline	<0.5 mL/kg/h for ≥12 h
3	3.0 times baseline OR Increase to ≥354 μmol/L OR Initiation of dialysis OR In patients <18 years, decrease in estimated glomerular filtration rate (eGFR) to <35 mL/min per 1.73 m^2 (Schwartz formula)	<0.3 mL/kg/h for ≥24 h OR Anuria for ≥12 h

This definition of both AKI and its staging originals from a proposal to simplify and unify both the RIFLE[1] and AKIN[2] systems, when literature has demonstrated similar stepwise increments in mortality and need for renal replacement therapy (RRT) associated with staging used in either criteria.[3–5] Indeed, the two criteria identified somewhat different patients, and data suggest that the use of both help identify more AKI patients than using either alone.[6] Although the urine output criteria remain less well validated than the creatinine-based criteria,[7] studies using both SCr and urine output show an increased AKI incidence, suggesting that the use of SCr alone may miss a number of patients.

- SCr level can vary rapidly as a result of diet, activity and interferences in assay from chromogens. Changes in muscle mass and fluid balance can all affect the serum levels, while urine output in the very obese subjects also needs to be cautioned. Clinical judgment is thus crucial in the interpretation.
- It is recommended that the first documented SCr value of the episode would be treated as the 'baseline'.[8]
- There is evidence demonstrating that the evaluation of urine output in 6-h blocks is as accurate as hourly observation, and this is particularly relevant in the non-intensive care unit (ICU) setting, and would obviate the need for bladder catheterization.[9]
- Patients should be staged according to the criteria that would give them the highest stage.
- The cause of AKI should try to be determined. (Not Graded)
  Generally, discontinuation of nephrotoxic agents whenever possible, maintenance of volume status and perfusion pressure, functional haemodynamic monitoring and that of SCr and urine output, avoiding hyperglycaemia and resort to alternatives avoiding radio-contrast procedures should all be considered for patients at high risk of or have developed AKI. Patients with AKI require diagnostic workup, and stage 2/3 patients require change in drug dosing as renal impairment advances and consideration for RRT.
- It is recommended that patients be stratified for risk of AKI according to their susceptibilities and exposures (R), and managed accordingly in order to reduce such risk. (Not Graded)
  Exposures that may cause AKI include sepsis, critical illness, circulatory shock, burns, trauma, cardiac surgery (especially with cardiopulmonary bypass), major non-cardiac surgery, nephrotoxic drugs, radio-contrast media, poisonous plants and animals. Even with these exposures, the risk of AKI would vary between different patient groups and in different clinical context.
- For patients at increased risk for AKI, monitor their SCr and urine output to detect (and stage severity) AKI, at individualized frequency and duration based on patient risk and clinical course. (Not Graded)
  The use of SCr and urine output would be meaningful when these are monitored regularly at a defined fashion, but clinical practice would usually be dictated by clinical judgment based on the clinical setting and indication, with a tendency for high-risk and critically ill patients being monitored more frequently. The availability of time-dependent biomarkers would be helpful.
- Manage patients with AKI according to the stage and cause. (Not Graded)

High risk	• Avoid nephrotoxic agents • Optimize volume status and monitor haemodynamic status • Monitor SCr and urine output • Control stress hyperglycaemia • Avoid iodinated contrast media and consider alternative imaging
Stage 1	• Diagnostic workup
Stage 2/3	• Adjust drug dosing for renal impairment • Consider timing for RRT • Consider ICU admission

The proposed stepwise approach to management based on the degree of severity of AKI requires validation.[7]

- Evaluate patients 2 months after AKI to look for return to baseline, or development of new CKD or worsening of pre-existing CKD. (R)
  There is strong association of AKI with subsequent development of CKD and end-stage renal disease (ESRD).[10,11] Prediction tools have been tested to help identify patients with AKI who are at high risks of CKD.[10,12–14]

2. Prevention and Treatment

- For initial fluid replacement in hypovolemic (not haemorrhagic) patients at risk for, or with, AKI, isotonic crystalloids rather than albumin or starches are recommended. (R)
  Recent data from multi-centre, open-label trial continues to support this recommendation.[15–17] The Acute Dialysis Quality Initiative group recently concluded on the evidence for harm with hetastarch (hydoxyethyl starch) or albumin administration in traumatic brain injury cases.[18] While 0.9% saline may result in a chloride-induced tubule-glomerular feedback–mediated vasoconstriction and metabolic acidosis compared with more physiologically balanced and buffered crystalloids, supporting evidence is mainly derived from post hoc analyses of large patient data sets, rather than prospective, controlled trials.[19]
- Vasopressors are recommended in volume-resuscitated patients with vasomotor shock at risk for, or with, AKI. (R)
  Current clinical data are insufficient to conclude on the best vasoactive agent in preventing AKI.[20–23]

- Protocoled therapies with specific physiological goals (haemodynamic and tissue oxygenation targets) are suggested to reduce perioperative AKI in high-risk patients. (D)
  The results from few multi-centre trials that looked at protocoled resuscitation with or without an oximetric central venous oxygen saturation monitoring (early goal-directed therapy) failed to suggest survival benefit in patients with septic shock who have received timely antibiotics and usual fluid resuscitation.[24–26] In high-risk patients in the perioperative setting, while studies using different protocoled therapies with specific physiological goals (haemodynamic and tissue oxygenation targets)[27] have been shown to significantly reduce post-operative AKI, there is no evidence to support the identification of the best regime.
- In patients with stress hyperglycaemia, the target plasma glucose for insulin therapy is suggested to be 6.1–8.3 mmol/L, and to avoid hypoglycaemia. (D)
  It is important to avoid the danger of potentially serious hypoglycaemia. While the target blood glucose between 6.1 and 8.3 mmol/L have not been directly studied in randomized controlled trial (RCT), they are interpolated from the comparisons tested in the trials.[28,29]
- An energy intake of 20–30 kcal/kg per day is suggested, and enteral feeding is preferred. (D)
  Though the optimal energy intake has not been well determined, data from both retrospective and randomized trials in AKI patients support a total energy intake of at least 20, but not to exceed 25–30 kcal/kg per day.[30,31] Studies have suggested that enteral feeding is associated with improved outcome and survival in ICU patients.[32–34]
- Protein intake is suggested to be 0.8–1.0 g/kg per day in non-catabolic patients not on dialysis, 1.0–1.5 g/kg per day in dialysis patients and up to 1.7 g/kg per day in hypercatabolic patients or patients on continuous renal replacement therapy (CRRT). (D)
  Since malnutrition is associated with increased mortality in critically ill patients, nutritional protein administration is not recommended to be restricted as a means to attenuate the rise in serum urea level when renal function declines. On the other hand, there is little evidence that hypercatabolism can be overcome by increasing protein intake to higher than physiological levels.[35,36] During RRT, nutritional support should include replacement for the losses during the procedures, especially with modalities associated with high filtration rates, including CRRT, sustained low efficiency dialysis (SLED) or peritoneal dialysis (PD).[37]
- The use of diuretics to prevent (R) or treat (D) AKI is not recommended, except in the presence of volume overload or acute decompensated heart failure (ADHF).
  Though diuretics theoretically may reduce renal tubular oxygen consumption and attenuate intra-tubular obstruction, the benefits of its use has remained contentious in AKI prevention. In the setting of cardiac surgery, a double-blind RCT has demonstrated a higher rate of AKI being associated with the use of furosemide.[38,39] Studies have suggested that diuretics given to treat post-operative AKI is best avoided.[40,41] This also applies to patients on CRRT.[42,43] In patients with ADHF, there were no significant differences in symptom relief or renal safety when diuretic therapy was administered by bolus compared with continuous infusion.[44] Although high-dose therapy (2.5 times the usual oral dose given intravenously) improved diuresis, with a trend towards improved symptom relief, there was associated increase in renal adverse events compared with low-dose therapy (usual oral dose given intravenously).[45] Individual careful clinical judgment is needed.
- The use of low-dose dopamine to prevent or treat AKI is not recommended. (R)
  The early positive results in the use of dopamine for renal protection in the critically ill have been opposed by quality RCT trial and meta-analysis.[45–47] The use of either dopamine or synthetic natriuretic peptide on top of standard therapy in ADHF is also not associated with enhanced pulmonary decongestion or improved renal function.[48] This is also true in the setting of AKI after cardiac surgery.[49,50]
- The use of fenoldopam to prevent or treat AKI is not suggested. (D)
  Fenoldopam mesylate is a dopamine type-1 receptor agonist with similar haemodynamic renal effects as low-dose dopamine, without systemic α- or β-adrenergic stimulation. While early data suggests a lower incidence of AKI was associated with the use of fenoldopam, data from adequately powered multi-centre trials with clinically significant endpoints do not support recommending fenoldopam to either prevent or treat AKI,[51,52] noting in particular the concern of the associated hypotension.
- The use of atrial natriuretic peptide to prevent or treat AKI is not suggested. (D)
  Studies demonstrating benefits of recombinant human atrial natriuretic peptide in reduced need for dialysis and improved dialysis-free survival after cardiac surgery[53] or solid organ transplantation tend to be underpowered, its routine use for the prevention or treatment of AKI cannot be recommended, the concern of hypotension aside.[53–56]
- The use of off-pump coronary artery bypass graft in order to prevent post-operative AKI is not suggested. (D)
  While the conclusion from systematic review and meta-analysis of studies looking at off-pump surgery compared with on-pump surgery in cardiopulmonary bypass suggest a 43% reduction in the risk of post-operative AKI, it has been cautioned that the definitions of AKI were variable and that the RCT included were associated with lower than normal event rates.[57–60] More data is thus awaited to reach a recommendation.

3. Dialysis Intervention

- Use traditional indications for RRT that include fluid status, electrolyte and acid–base balance, clinical context. (Not Graded)

  The optimal timing of initiation of RRT has yet to be determined, and is largely a clinical decision. In recent prospective studies, conflicting results have been obtained, with different definitions of early versus conventional initiation of dialysis being used.[61–64] Thus, while traditional indications for RRT used for patients with CKD may not necessarily be valid for AKI, the best timing for RRT may only be confirmed through prospective RCT when there are candidate biomarkers, enabling the selection of the right target patients and the offer of therapy at the right time. There is a general trend to commence RRT earlier in the more critically ill.[65,66]
- The use of diuretics to enhance kidney function recovery is not suggested. (D)

  One RCT has evaluated the role of furosemide by continuous infusion at a rate of 0.5 mg/kg/h on top of continuous veno-venous hemofiltration (CVVH). While treated patients had a significantly increased urinary volume and greater sodium excretion compared to the controls, there were no differences in the need for repeated CVVH, or renal recovery during ICU or hospital stay.[42]
- The use of anti-coagulation during RRT, except those with bleeding risk, is recommended: (R)
  a. For intermittent RRT, either unfractionated or low-molecular-weight heparin, is recommended. (R)
  b. For CRRT, regional citrate anti-coagulation is suggested. (D)
  c. For CRRT in patients who have contraindications for citrate, either unfractionated or low-molecular-weight heparin, is suggested. (D)

     Studies have shown that frequent clotting affected RRT treatment efficacy, increased circuit 'down time', and increased transfusion requirements and cost.[67]

     The advantages of unfractionated heparin include low cost, wide availability, easy administration and monitoring and availability of antidote. Its disadvantages include unpredictable and complex pharmacokinetics, risk of heparin-induced thrombocytopenia, heparin resistance from low circulating anti-thrombin III levels and increased risk of haemorrhage. Data from studies in chronic haemodialysis (HD) comparing unfractionated with low-molecular-weight heparin concluded that both are equally safe in terms of bleeding complications and effectiveness in maintaining circuit patency.[68]

     Recent meta-analyses concluded that regional citrate anticoagulation (RCA) decreased the risk of bleeding compared with heparin anti-coagulation, improved circuit patency, especially in patients with increased bleeding risk, provided that appropriate protocols for monitoring are in place to eliminate the risk of citrate toxicity.[69] Unexpectedly, there are studies showing improved renal recovery and hospital survival associated with the use of RCA, awaiting further confirmation.[70]

     Patients with severe liver failure may have difficulty metabolizing the calcium–citrate complex, resulting in citrate accumulation, characterized by low ionized calcium levels, and high anion gap metabolic acidosis.
- For patients with increased bleeding risk, regional citrate anti-coagulation during CRRT, unless with contraindications, is suggested. (D)
- Both continuous and intermittent RRT are complementary therapies in AKI patients. (Not Graded)

  Both intermittent HD and CRRT should be regarded as complementary modalities of RRT, as supported by the absence of definitive data favouring either one, in terms of hospital or ICU mortality, length of hospitalization and renal recovery in survivors.[71,72] Also, availability, expertise, resources, cost and physician preference would influence the clinical choice. Transitions between both modalities would be based on the changing clinical status of the patient, technical considerations such as circuit 'down time', and clinical needs of the patients such as rescheduling of diagnostic or therapeutic procedures.
- CRRT instead of intermittent HD, is the suggested modality for both haemodynamically unstable patients and patients with raised intracranial pressure. (D)

  CRRT, rather than intermittent HD, resulted in a significantly higher mean arterial pressure and a lower requirement of vasopressor therapy.[71] SLED is generally well tolerated in the settings where CRRT is commonly used and may have a role when other forms of CRRT are not available, but data from comparative studies are limited. Intermittent HD in patients with raised intracranial pressure (acute brain injury or brain oedema) may compromise cerebral perfusion pressure as a result of HD-associated hypotension or by aggravating cerebral oedema and intracranial pressure through rapid intracellular volume and solute shifts.[73–76]
- A Kt/V of 3.9 per week for intermittent HD is recommended (R), and the actual delivery should be closely monitored (R).

  Two well-conducted RCT looking at the dialytic dose of intermittent HD in AKI failed to demonstrate improvement in mortality or renal recovery when the dialysis dose was increased, either by a higher Kt/V above 3.9 weekly or by maintaining a serum urea level <15 mmol/L.[77,78] It is thus recommended to offer thrice-weekly Kt/V of 1.3 for intermittent HD in AKI. More frequent dialysis treatments may, however, be required in order to optimize fluid control, in hypercatabolic individuals or in the presence of severe hyperkalaemia or acidaemia. Positive fluid balance has been shown to be an independent risk factor for mortality in AKI patients.[79]

- An effluent volume of 20–25 mL/kg/h for CRRT is recommended. (R)
  The two large, multi-centre RCT, the Veterans Affairs/National Institutes of Health Acute Renal Failure Trial Network Study[77] and the Randomized Evaluation of Normal versus Augmented Level Renal Replacement Therapy (RENAL) trial[80] did not confirm that a more intensive therapy (CVVHDF with effluent flow exceeding 20–25 mL/kg/h) was associated with improved patient survival or recovery of renal function. However, studies in CRRT have shown that delivery usually falls substantially short of the prescribed dose[81] as a result of technical problems such as poor blood flows, reduced haemofilter efficiency with time or filter clotting. It is thus generally recommended to prescribe a higher dose at 25–30 mL/kg/h, in order to achieve the recommended target.

4. Specific Clinical Settings

4.1 Contrast-induced AKI

- In patients suspected to have contrast-induced (CI)-AKI, look out for other possible causes of AKI too. (Not Graded)
  The incidence may be as high as 25% in patients with pre-existing renal impairment or together with other risk factors such as diabetes, congestive heart failure, advanced age and concurrent administration of nephrotoxic drugs.[82–84] Patients who develop CI-AKI have a greater risk for death or prolonged hospitalization.[85,86] Monitoring of SCr following contrast exposure is essential, looking for new-onset CKD.[87]
- Assess the risk for CI-AKI and always screen for renal impairment in patients planned for a procedure that involves intravascular (i.v. or i.a.) administration of iodinated contrast medium, and consider alternative examinations in patients at increased risk. (Not Graded)
  While the CI-AKI Consensus Working Panel suggested that the risk of CI-AKI becomes clinically important when the baseline SCr concentration is ≥115 mmol/L in men and ≥ 88.4 mmol/L in women, equivalent to an eGFR <60 mL/min per 1.73 m^2, there are recent data suggesting that patients with SCr concentration >159 mmol/L are the group at risk.[88] When a recent SCr is not available, a simple questionnaire or a dipstick testing for urine protein may be useful for identifying pre-existing kidney disease.[89,90] The risk of CI-AKI appears to be greater after arterial compared to venous administration of contrast media, with an overall CI-AKI incidence of about 5% after procedures that involve intravenous low-osmolar contrast media.[91] Controversial risk factors include diabetes, hypertension, congestive heart failure, advanced age, volume depletion (including the use of loop diuretics), haemodynamic instability, concurrent use of nephrotoxic drugs, metabolic syndrome, multiple myeloma, female gender, cirrhosis and large volume or high osmolality of the contrast media.
- The use of either iso-osmolar or low-osmolar iodinated contrast media, but not high-osmolar iodinated contrast media (R), at the lowest possible dose (Not Graded) in patients at increased risk is recommended.
  Repeated exposure should preferably be delayed for 48 h in patients without risk factors for CI-AKI, and for 72 h in those with risk factors. If AKI develops after contrast-media administration, repeat exposure should be postponed until the SCr level has returned to baseline.[92]

A meta-analysis looking at 24 randomized studies suggests that low-osmolar contrast media are less nephrotoxic than high-osmolar agents in patients with pre-existing renal impairment.[93] Clinical heterogeneity in terms of baseline risk profile, definitions of CI-CKI and timing of SCr measurement, among the studies comparing the iso-osmolar contrast media with low-osmolar agents in high-risk patients make it difficult to reach a conclusive recommendation.[94–97]

- We suggest that in high-risk patients, a repeat SCr is performed 12 and 72 h after administration of contrast media. (D)[98,99]
- Intravenous fluid (unless clinically contraindicated), either isotonic sodium chloride or sodium bicarbonate, is recommended for patients at increased risk. (R)
  Despite the absence of RCT that directly evaluate the role of intravenous fluids versus placebo in the prevention of AKI, comparisons observed in trials looking at different fluids, when matched with historical untreated control subjects suggest a large benefit from fluids.[100] The possible exception would be patients with fluid overload. Even though there is no clear evidence from the literature to guide the choice of the optimal rate and duration of fluid administration in CI-AKI prevention, a 'good' urine output (>150 mL/h) in the 6 h after the radiological procedure has been associated with reduced rates of AKI.[101] As crystalloids given intravenously would not be retained in the vascular space for long, this target urine flow rate requires an infusion rate of around 1.0–1.5 mL/kg/h for 3–12 h before and 6–12 h after the contrast exposure.
  Isotonic 0.9% saline solution has been proven to be superior to 0.45% saline solution[102,103] in CI-AKI prevention. For the comparison between sodium bicarbonate and saline, meta-regression suggests that small studies tend to demonstrate the superiority of bicarbonate, even though there were no consistent effects in terms of the risk for dialysis, heart failure and total mortality.[104] The additional burden and potential harm from errors in preparing the bicarbonate solutions at the bedside or by local pharmacy, may further argue against the use of this fluid at present. The on-going, large, multi-centre, randomized, double-blind controlled trial comparing isotonic sodium

bicarbonate with isotonic saline, along with N-acetylcysteine (NAC) versus placebo, for CI-AKI prevention, the PRESERVE study, has scheduled to enrol 8000 participants. The fluid prescription personalized to the volume status of individual patients represents a promising approach when compared with the usual weight-based fluid prescriptions of specified duration pre-contrast and post-contrast exposure. One such trial utilized the invasively measured left ventricular end diastolic pressure in high-risk patients undergoing cardiac catheterization.[105] The other approaches tested include device-assisted fluid administration matched with urine output[106] or inferior vena cava volume measurement.

- We suggest using oral NAC, together with intravenous fluid, in patients at increased risk. (D)
  The effect of NAC on the incidence of CI-AKI is quite variable, with most of the published studies being relatively small in size. With marked heterogeneity in the studies recruited, it is not surprising that many but not all meta-analyses revealed a net benefit.[107] There is at present no evidence that either oral or intravenous NAC can alter hard outcomes including mortality and need for RRT after contrast-media administration to patients at risk for CI-AKI. The overall benefit of NAC is not consistent or overwhelming.[108] However, oral NAC has a good safety profile and is inexpensive. Also, studies of NAC combined with bicarbonate administration have shown substantially reduced overall incidence of CI-AKI, but not that of dialysis-dependent renal failure, when compared to the combination of NAC with saline.[109,110]
- The use of statins as an alternative to volume expansion is not suggested. (Not Graded)
  Although recent RCT are associated with significant study limitations including the focus on relatively low-risk populations, they consistently demonstrate the efficacy of rosuvastatin for prevention of CI-AKI, including among the subgroups of CKD patients, echoing the results from previous meta-analyses. Studies devoted to patients with stage 3–4 CKD, however, would be crucial to support a definitive conclusion.[111,112]
- The use of prophylactic HD or haemofiltration for contrast-media removal in patients at increased risk is not suggested. (D)
  While there are conflicting data on the use of prophylactic intermittent HD in the incidence of CI-AKI, leading to either increased harm[113] or tendency towards being useful,[114,115] a recent meta-analysis of studies using periprocedural extracorporeal blood purification techniques concluded that such treatments did not decrease the incidence of CI-AKI.[116]

4.2 Hepatorenal syndrome

- Use of vasoconstrictors such as terlipressin, norepinephrine or midodrine plus octreotide combined with volume resuscitation by infusion of 20–25% albumin is recommended for type 1 hepatorenal syndrome (HRS) in the setting of liver cirrhosis. (R)

HRS type 1 represents a severe form of AKI in chronic liver disease characterized by systemic and splanchnic haemodynamic abnormalities without concomitant structural kidney injury. The diagnosis requires demonstration of a recent rise in SCr and exclusion of other causes of AKI such as hypovolaemia, drugs and parenchymal renal disease. There are data showing that early initiation of treatment with vasoconstrictor therapy coupled with albumin infusion might improve patient survival and renal outcomes.[117,118]

B. CHRONIC KIDNEY DISEASE

1. Definition and Classification

The National Kidney Foundation defined CKD as either kidney damage or GFR <60 mL/min per 1.73 m^2 for ≥3 months.[119] Kidney damage is defined as pathological abnormalities or the presence of markers of damage, including abnormalities in blood or urine tests or imaging studies. Damage to the kidney can be within the parenchyma, large blood vessels or collecting systems. The markers of kidney damage often provide a clue to the probable site of damage within the kidney and in association with other clinical findings, the aetiology of kidney disease.

In 2012, Kidney Disease: Improving Global Outcomes (KDIGO) re-defined CKD as abnormalities of kidney structure or function, present for more than 3 months, with implications for health. CKD is classified based on *C*ause, *G*FR category and *A*lbuminuria category (CGA).[120]

The markers for kidney injury were specified as follows:

- Albuminuria (albumin excretion rate (AER) ≥30 mg/24 h; albumin-creatinine ratio (ACR) ≥30 mg/g (≥3 mg/mmol))
- Urine sediment abnormalities, especially renal tubular cells, red blood cells (RBC)/white blood cell casts, dysmorphic RBC
- Electrolyte and other abnormalities due to tubular disorders
- Abnormalities detected by histology
- Structural abnormalities detected by imaging
- History of kidney transplantation

The stages of CKD were arbitrarily classified as follows:

GFR category	GFR (mL/min per 1.73 m^2)	Description
G1[†]	≥90	Normal or ↑ GFR
G2[†]	60–89	Mild ↓ GFR
G3a	45–59	Mild-to-moderate ↓ GFR
G3b	30–44	Moderate-to-severe ↓ GFR
G4	15–29	Severe ↓ GFR
G5	<15 or dialysis	Kidney failure

[†]In the absence of evidence of kidney damage, neither GFR category G1 nor G2 fulfil the criteria for CKD.

The albuminuria categories in CKD were classified as follows:

Albuminuria category[†]	AER (mg/24 h)	ACR (approximately) in mg/mmol	ACR (approximately) in mg/g	Description
A1	<30	<3	<30	Normal or mild ↑
A2	30–300	3–30	30–300	Moderate ↑
A3	>300	>30	>300	Severe ↑

[†]Correlates with renal prognosis.

The classification was also expanded by KDOQI (2012) to reveal treatment status, as follows:

CKD categories	Definition
CKD	CKD of any stage,[119–123] with or without a kidney transplant, including both non–dialysis dependent CKD (CKD 1–5ND) and dialysis-dependent CKD (CKD 5D)
CKD ND	Non–dialysis-dependent CKD of any stage,[119–123] with or without a kidney transplant (i.e. CKD excluding CKD 5D)
CKD T	Non–dialysis-dependent CKD of any stage[119–123] with a kidney transplant

Specific examples and meanings:

CKD 1, 2, 3, 4	Specific stages of CKD, CKD ND or CKD T
CKD 3–4 and so on	Range of CKD stages
CKD 5D	Dialysis-dependent CKD 5
CKD 5HD	HD-dependent CKD 5
CKD 5PD	Peritoneal dialysis–dependent CKD 5

2. Risk Factors

Studies reveal that a substantial proportion of people without known history of CKD may actually harbour subclinical CKD. Individuals at increased risk of developing CKD should undergo testing for markers of kidney damage, and to estimate the level of GFR. The risk factors include but are not limited to the following conditions:

- Advanced age
- Diabetes
- Hypertension
- Heart failure
- Smoking
- Obesity
- Autoimmune disease, for example systemic lupus erythematosus, vasculitis
- Neoplasia
- Systemic or recurrent urinary tract infections
- Hereditary kidney disease
- Recovery from AKI
- Reduced kidney mass
- Ongoing exposure to nephrotoxic agents, for example analgesics
- Dyslipidaemia
- Low birth weight
- Race, for example African Americans, Aboriginals, etc.
- Severe socioeconomic disadvantage
- Family history of CKD/ESRD

All of the above are known risk factors with the exception that recent observations showed that are Associations with and prognostic impact of CKD in heart failure, with CKD being more common in preserved than in mid-range and reduced ejection fraction.[121]

3. Clinical Assessment and GFR Estimation

- Reporting of eGFRcreat in addition to SCr in adults is preferred and the equation used should be specified. (R)
  The original Modification of Diet in Renal Disease (MDRD) study equation[122] required more variables (including blood urea nitrogen and serum albumin) than was thought to be practicable for routine clinical practice, and an abbreviated four-variable version was eventually adopted and widely used in clinical practice.[123] The MDRD study equation was limited to only estimating GFR in CKD patients, as GFR is underestimated when applied to patients with kidney function better than 60 mL/min per 1.73 m^2. Subsequently, KDIGO recommended the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation[124] designed to overcome the shortcomings of the MDRD study equation. CKD-EPI was derived from an ethnically broader population and included both healthy participants and subjects with CKD. Even then, it must be borne in mind that the validity of the CKD-EPI equation in non-European and non-African ethnicities remains uncertain. Other methods of improving the accuracy of the estimating equations include the use of an alternative or additional serum biomarker, and also muscle mass quantification to adjust for variations in SCr. Thus, the CKD-EPI collaboration group further developed an equation that used both SCr and cystatin C.[125] Several investigators in Asia (including China, Japan, Korea, Taiwan and Thailand) assessed the performance of the various GFR estimating equations, in particular, the MDRD study equation, the CKD-EPI equation (creatinine only), and the CKD-EPI equations (creatinine and cystatin C). Since cystatin C measurement is not widely available in Hong Kong, we will adopt the most current KDIGO guideline that recommended using the CKD-EPI SCr-based GFR estimating equation.

- Measuring SCr using a specific assay with calibration traceable to international standards and minimal bias compared to isotope-dilution mass spectrometry reference methodology is suggested. (D)
- In most patients, well-defined clinical scenarios together with non-invasive tests, for example serological and imaging studies, provide a sufficient basis to formulate a working diagnosis of CKD. (R)
- Kidney biopsy may be indicated when a definitive diagnosis would either change the treatment or provide useful information on prognosis. (R)
- In general, evaluation of patients with CKD requires understanding of the aetiology that triggers CKD, stage of the disease, comorbid conditions, complications of disease including cardiovascular morbidity, and risks for progression. Periodic assessment of GFR is also important as it allows estimation of the rate of change of renal function. (R)
- Review of medications should be performed regularly with regard to dosage adjustment based on the stage of CKD, and detection of potentially adverse effects on kidney function or complications of CKD. (R)

4. Screening for Early CKD

- Screening for CKD be targeted and performed in individuals at increased risk of developing CKD, including those with diabetes mellitus, hypertension and established cardiovascular disease (see item 2 above). (D)
  The screening tools should include history taking, blood pressure (BP) recording, urine dipstick testing for protein and red cells, and measurement of SCr. Other screening tests should be included for specific at-risk groups, for example urine microalbumin in diabetic subjects, or urinary albumin:creatinine ratio in dipstick-positive individuals.[126,127]

5. When to Refer for Specialist Care

- Patients with CKD should be referred to a specialist for consultation and co-management if the clinical action plan cannot be prepared, the prescribed evaluation of the patient cannot be carried out, or the recommended treatment cannot be instituted. (R)
  The criteria for specialist referral vary with individual practice and available resources.
  In general, the following scenarios deserve consideration of referral:
- CKD 4 or higher
- Anticipation of the need of initiation of renal replacement therapy within 1 year
- AKI or abrupt sustained fall in GFR
- Significant proteinuria, for example >1 g/24 h
- Urinary red cell casts, for example RBC >20 per high power field sustained and not readily explained
- CKD and hypertension refractory to treatment with four or more anti-hypertensive agents
- Persistent abnormalities of serum potassium not otherwise explained
- Recurrent urinary tract infections
- Hereditary kidney disease, for example autosomal dominant polycystic kidney disease (ADPKD)

6. General Management Strategies

The management of progression of CKD is aimed at tackling a myriad of factors known to be associated with progression. These measures have been shown to modify cardiovascular health and CKD concomitantly or separately. Addressing CV risk factors may indirectly and directly impact CKD progression, and vice-versa. Strategies include general lifestyle measures, salt restriction, BP control and blockade of the renin-angiotensin-aldosterone system. In addition, control of other metabolic parameters such as blood sugar, lipid, anaemia, bone metabolism, uric acid and acidosis are also important.[120]

6.1 Blood pressure control

- BP targets should be tailored according to age, tolerability and the level of proteinuria. (D)
- An angiotensin receptor blocker (ARB) or angiotensin-converting enzyme (ACE)-I is suggested for both diabetic and non-diabetic patients with CKD and urine albumin excretion >300 mg/24 h (or equivalent), unless the use of renin–angiotensin system (RAS) blockers is limited by intractable hyperkalaemia. (R)
- For diabetic and non-diabetic patients with AER less than 30 mg/24 h (or equivalent), the suggested BP target is ≤140/90 mmHg. For diabetic and non-diabetic patients with UAE ≥30 mg/24 h (or equivalent), the suggested BP target is ≤130/80 mmHg. (D)
  Available evidence is inconclusive but does not prove that a blood pressure target of less than 130/80 mmHg improves clinical outcomes more than a target of less than 140/90 mmHg in adults with CKD.[128]

6.2 Anti-proteinuric measures

The level of proteinuria has been shown to correlate with renal prognosis in both diabetic and non-diabetic CKD.[129]

- Every attempt should be made to lower proteinuria. (R)
- Treatment with a RAS blocker (ACEi or ARB) appears to be the only proven therapeutic option. (D)
- Combination of ACEi/ARB, ARB/mineralocorticoid receptor blocker or ARB/direct renin inhibitor is in general not recommended due to potential adverse events, mainly AKI, hyperkalaemia or hypotension. (D)

6.3 Lipid lowering

- Adults over 50 years old with CKD G3a–G5 ND could be treated with a statin or statin/ezetimibe combination. (D)
  Recent studies have shed light on lipid management in patients with CKD. Although definitive evidence is still lacking, these studies suggest that lipid lowering could only confer tangible cardiovascular protection during early rather than late CKD.[130]
- For those in GFR categories G1–G2, treatment with a statin is desirable. (D)
- In younger subjects below 50 years of age with CKD ND, statin treatment is recommended if there is an additional cardiovascular risk factor, namely known coronary heart disease, diabetes, prior ischemic stroke or an estimated 10-years incidence of coronary death or non-fatal myocardial infarction (MI) >10%. (D)
- For dialysis-dependent patients and kidney transplant recipients, follow-up measurement of lipid levels is not required for most patients, and treatment with a statin should be individualized. For those to be treated, dosage adjustment for reduced GFR is generally required. (D)
- The dose of statin should be titrated to achieve the target level of Low-density lipoprotein (LDL) cholesterol, which in turn is determined by each patient's presumed coronary risk. (D)
- For renoprotection, lowering LDL cholesterol by 1 mmol/L did not slow kidney disease progression within 5 years in a wide range of patients with CKD in a large randomized study using simvastatin/ezetimibe combination. (ungraded)
  Exploratory analyses of the SHARP study, however, showed no significant effect of lipid lowering on the rate of change in eGFR.[131] A more recent study (PLANET I)* found atorvastatin to have more renoprotective effects than high-dose rosuvastatin in patients with diabetes who have progressive renal disease.[132]

6.4 Correction of anaemia

The first principle is to address all correctable causes of anaemia (such as iron deficiency and occult inflammatory states) prior to initiation of an erythropoiesis-stimulating agent (ESA). It is also important to balance the potential benefits of reducing blood transfusions and anaemia-related symptoms against the risk of side effects such as hypertension, stroke and vascular access loss. Landmark clinical trials of the last decade have shed light on the optimal target haemoglobin levels in the CKD population.[133–135]

- For CKD ND patients, initiation of ESA should be individualized based mainly on symptoms, but also on prior response to iron therapy and the risk of blood transfusion. (D)
- For CKD 5D patients, ESA can be commenced as haemoglobin falls below 9 g/dL. The target haemoglobin level should be around 11.5 g/dL. The route of administration should be intravenous or subcutaneous for CKD 5HD, and subcutaneous for CKD ND and CKD 5PD patients. (D)

6.5 Bone metabolism

- Dietary phosphate reduction should be implemented during CKD 3–4 when plasma intact parathyroid hormone (iPTH) levels exceed 70 pg/mL (7.7 pmol/L) (stage 3) or >110 pg/mL (12.1 pmol/L) (stage 4). (D)
  The major disorders can be classified into those associated with high bone turnover and high PTH levels (including osteitis fibrosa, the hallmark lesion of secondary hyperparathyroidism and mixed lesion) and low bone turnover and low or normal PTH levels (osteomalacia and adynamic bone disease). The abnormalities that lead to bone disease begin to occur at earlier stages of CKD. Elevated levels of PTH and phosphorus, reduced levels of calcium and reduced urinary phosphate excretion have been described among patients with GFR <70 mL/min or lower.[119]
- Vitamin D or analogues are useful in treating secondary hyperparathyroidism (SHPT) (D)
  Treatment of SHPT with oral or intravenous calcitriol or paricalcitol can reduce the elevated levels of iPTH, and may be useful to treat various clinical features of symptomatic secondary hyperparathyroidism, such as improved features of hyperparathyroid bone disease as reflected by reductions of serum alkaline phosphatase (and/or bone-specific alkaline phosphatase).
- The desirable iPTH threshold for commencing treatment in CKD 5HD and CKD 5PD patients is 300 pg/mL (33.0 pmol/L), and the target iPTH is 150–300 pg/mL (16.5–33.0 pmol/L). (D)
- For patients with the corrected CaxPO4 product above the target range, a trial of alternative vitamin D analogs, such as paricalcitol, is recommended. (R)
- Calcimimetic agents can be considered when vitamin D or its analogue is ineffective or contraindicated. (Not Graded)
  There is less data on the use of calcimimetic agents. Treatment with cinacalcet reduces levels of PTH, CaxPO4 product and may reduce rates of parathyroidectomy and fracture. The use of cinacalcet may be associated with development of adynamic bone disease when iPTH values are <10.6 pmol/L (<100 pg/mL).

6.6 Hyperuricaemia management

- There is insufficient evidence to support the routine use of uric acid lowering agents in retarding the progression

*Correction added June 2019, after original publication: spelling of 'PLANET I' corrected.

of CKD in either symptomatic or asymptomatic hyperuricaemia. (Not Graded)
There is also insufficient evidence to suggest that HLA-B*5801 genotyping is less costly and more effective than treatment without genotyping in terms of reducing the occurrence of allopurinol-induced severe cutaneous adverse reactions and related complications.

6.7 Nutritional considerations

Dietary intervention should be considered in CKD patients in the context of maintaining a satisfactory nutritional status.

- For patients with early CKD, a normal protein diet, consisting of 0.75–1.0 g/kg per day, with adequate caloric intake is desirable. Dietary sodium intake should be limited to 100 mmol/day (or 2.3 g sodium or 6 g salt per day), as it reduces blood pressure and albuminuria, and enhances the anti-proteinuric efficacy of RAS blockers. (D)
- The recommended daily allowance of dietary protein intake at 0.75 g/kg per day appears reasonable in patients with GFR >30 mL/min per 1.73 m^2 (CKD 1–3). (D)
  There is insufficient evidence to recommend for or against routine prescription of dietary protein restriction to slow the progression CKD.
- A lower protein intake of 0.6 g/kg per day can be considered for patients with lower GFR (CKD 4 and 5) to slow progression and minimize accumulation of uremic toxins. (D)
  Individual decision-making is required after balancing the potential risks and benefits. There is recent anecdotal experience that ketoanalogue-supplemented vegetarian very low-protein diet (0.3 g/kg) could retard the progression of CKD compared with conventional low-protein diet.[136]
- Patients with CKD should receive expert dietetic advice and information tailored to the stage of CKD and the need to intervene on sodium, phosphate, potassium and fluid intake. (R)

7. Diabetic Kidney Disease

7.1 Primary prevention

- Optimal glycaemic control is recommended, though this has to be balanced against the risk of hypoglycaemia particularly in susceptible individuals such as elderly subjects. (R)
  Hyperglycaemia, the defining metabolic feature of diabetes, is a fundamental cause of vascular target organ complications, including diabetic kidney disease (DKD). Previous and recent studies have confirmed the efficacy of intensive glycaemic control in preventing or retarding the onset of DKD.[137,138] Intensive treatment of hyperglycaemia carries with it an inherently increased risk of hypoglycaemia.[139]
- RAS blockers may be considered as a preventive measure against DKD. (D)
  The use of RAS blocker even before the onset of microalbuminuria has also been shown to delay the onset of DKD. It must be borne in mind, however, that unmodifiable factors, such as genetic predisposition, operate in the context of DKD.[139]

7.2 Retardation of progression

- RAS blockade is desirable in reducing albuminuria and the risk of renal end points in established DKD. (R)
- Treatments that produce a lasting decrease in albuminuria excretion may slow the progression of DKD even in the absence of hypertension, although most people with diabetes and albuminuria have hypertension. (D)
- Combination of ACEi/ARB, ARB/mineralocorticoid receptor antagonist (MRA) or ARB/direct renin inhibitor is in general not recommended due to potential adverse events. (D)
  Although the level of residual proteinuria is a significant prognostic indicator, these anti-proteinuric measures have been reported to carry significant untoward effects such as hyperkalaemia, hypotension or even AKI.[140]
- The non-steroidal MRA could have a lower incidence of hyperkalaemia. (Not Graded)
  The only RAS blocker that may be potentially combined with an ACEi or ARB is the novel non-steroidal MRA finerenone[141] that has greater receptor selectivity than spironolactone and better receptor affinity than eplerenone *in vitro* with a lower incidence of hyperkalaemia than spironolactone.
- An HbA1c target of ≤7.0% is desirable to prevent or delay the onset or progression of microvascular complications including DKD. (R)
- In patients at risk of hypoglycaemia, for example the elderly, and in individuals with comorbidities or limited life expectancy, the HbA1c target should be relaxed to ≥7.0%. (D)

7.3 Glycaemic control in DKD with CKD stage 3B or higher (eGFR <45 mL/min)

- Metformin in a dose adapted to renal function as a first line agent should be mandated. (R)
  Meticulous management of glycaemic control is required for this category of patients.
- When improvement of glycaemic control is deemed appropriate, a drug with a low risk for hypoglycaemia should be chosen as an additional agent. (D)
- Temporary withdrawal of metformin should be exercised in conditions that foster any form of AKI, for example

systemic infection, impending dehydration, exposure to contrast media. (R)
- The sodium-glucose co-transporter 2 (SGLT2) inhibitor is generally not recommended for this range of renal function. (Not Graded)

8. Precautions for Special Investigations

8.1 Use of intravenous gadolinium-containing contrast

- Intravenous gadolinium contrast should not be used in patients with eGFR <15 mL/min per 1.73 m^2, and is not recommended for high risk patients with eGFR <30 mL/min per 1.73 m^2, hepatorenal syndrome, and AKI. It should be used with caution at the minimum dose in lower risk patients with eGFR 30–45 mL/min per 1.73 m^2. Patients with eGFR >45 mL/min have negligible risk. (D)
  Use of intravenous gadolinium contrast is associated with increased risk of NSF in patients with significant renal function impairment. The condition is characterized by diffuse fibrosis of the skin and other tissues and the exact aetiology is unknown.[142]

8.2 Bowel preparation for colonoscopy

- Oral phosphate-containing bowel preparations should not be used in people with a GFR <60 mL/min per 1.73 m^2. (R)
  Advanced CKD is a risk factor for acute phosphate nephropathy from consumption of oral phosphate-containing bowel preparations, which should not be used in people with low GFR.

C. GLOMERULONEPHRITIDES

1. General Considerations

1.1 Kidney biopsy

Kidney biopsy is mandatory for making a definitive histopathological diagnosis. Exceptions include steroid-sensitive nephrotic syndrome in children unless the clinical response is atypical, and where biopsy is contraindicated in adults. Adequacy of the biopsy relates to the size of the tissue necessary to diagnose a specific histopathological pattern with a reasonable level of confidence, and to allow assessment of the degree of acute or chronic damage. The Oxford Classification for IgA nephropathy for example mandates obtaining at least eight glomeruli on the biopsy.[143] Repeat kidney biopsy during therapy or following a relapse should only be considered if it may guide a change in therapy. There is no systematic evidence to support recommendations for when or how often it is necessary.

1.2 Proteinuria assessment

There is a lack of consensus whether urine albumin or protein excretion is the preferred measurement to assess glomerular injury. 24-h protein excretion remains the gold standard as it averages the variation of proteinuria due to the circadian rhythm, physical activity, and posture. Although this method is subject to error due to over- or under-collection, the simultaneous measurement of urine creatinine may improve its reliability. Protein-creatinine ratio (PCR) or ACR on a spot urine sample, or a first void morning urine sample, is a practical alternative to 24-h urine collection. It is increasingly used in clinical practice and in clinical trials because the sample is easy to obtain and is not affected by urine concentration influenced by variations in water intake.[144] Over the sub-nephrotic range, there is a correlation between PCR and 24-h protein excretion,[145] but is unreliable in patients with high protein excretion and should not be used in the clinical setting unless 24 h urine collection is unavailable. Nephrotic-range proteinuria is nearly always arbitrarily defined as proteinuria >3.5 g per 24 h.

1.3 Potential complications

1.3.1 Hypertension. Lifestyle modification (salt restriction, weight normalization, regular exercise and smoking cessation) should be an integral part of the therapy for blood pressure control. The ideal goal for blood pressure is not firmly established but current recommendations suggest that 130/80 mmHg should be the treatment goal. There are limited data to support a lower target of 125/75 mmHg if there is proteinuria >1 g/day.[128]

1.3.2 Symptomatic nephrotic oedema. The mainstay of treatment is diuretics and moderate dietary sodium restriction (1.5–2 g (60–80 mmol) sodium per 24 h). Oral loop diuretics with once- or twice-daily administration are usually preferred. However, in severe nephrotic syndrome, gastrointestinal absorption of the diuretic may be uncertain because of intestinal-wall oedema, and i.v. diuretic, by bolus injection or infusion, may be necessary to induce an effective diuresis. Alternatively, combining a loop diuretic with a thiazide diuretic or with metolazone is often an effective oral regimen.[144] Albumin infusions may be combined with diuretics to treat diuretic resistance, but are of unproven benefit.

1.3.3 Acute kidney injury. Severely nephrotic patients may develop AKI as a result intravascular contraction despite a grossly oedematous state. Albumin infusion with intravenous diuretic such as furosemide may provide transient symptomatic relief. Renal vein thrombosis is another potential cause of AKI due to a hypercoagulable state. The risk of thrombotic events increases significantly as serum albumin falls below 25 g/L.[144] Immobility as a consequence of

oedema or hospitalization can further aggravate the risk. Prophylactic low-dose anti-coagulation is common practice.

1.4 Special precaution

- Hepatitis serologies must be routinely obtained at diagnosis. (R)
  Hepatitis B virus (HBV) reactivations have been reported widely, even including liver failure and death, in patients who received immunosuppressive and biological agents.[146] In particular, HBsAg+ or anti-HBc+ patients are at high risk of HBV reactivation if they are to receive rituximab, or moderate (10–20 mg prednisone daily or equivalent) or high dose (>20 mg daily prednisone daily or equivalent) corticosteroids for ≥4 weeks. Some literature even suggests a threshold of 2 weeks.[147,148]
- HBV carriers who do not meet the criteria for antiviral treatment must receive prophylaxis before receiving such therapy. (R)
- Entecavir is preferred to lamivudine because of their better resistance profile during long-term immunosuppressant treatments. (D)
- For patients to be treated with high-dose corticosteroid or immunosuppression, pneumocystis pneumonia (PCP) prophylaxis should be instituted after ascertaining the G6PD status. (Not Graded)

2. Specific Primary/Systemic Glomerulonephritides

2.1 Minimal change disease

- Corticosteroid is the desirable first-line treatment. (R)
  The suggested dosage for the initial episode of minimal change disease (MCD) is prednisolone at a single daily dose of 1 mg/kg (maximum 80 mg daily). This initial high dose should be maintained for a minimum period of 4 weeks if complete remission (CR) is achieved, or for a maximum of 16 weeks of CR is not achieved. In patients who remit, corticosteroids should be tapered over a period of up to 6 months following remission.
- For frequently relapsing or steroid-dependent, addition of calcineurin inhibitor (CNI, cyclosporin or tacrolimus) for 1–2 years is recommended. (R)
  Mycophenolate (MMF) or cyclophosphamide (CTX) for the same duration are alternatives, particularly for patients who cannot tolerate high dose corticosteroids. Levamisole may also be considered.[149]
- For steroid-resistant MCD, addition of calcineurin inhibitor can be considered. (D)
  Before adding CNI, one must also re-evaluate for other causes of the nephrotic syndrome and consider repeating kidney biopsy for the possibility of focal segmental glomerulosclerosis (FSGS) or other pathologies.
- For the initial episode of nephrotic syndrome from MCD, statins are not recommended for nephrotic dyslipidaemia. In addition, RAS blockers are not recommended as an adjunct to lower proteinuria in normotensive patients. (D)

2.2 Focal segmental glomerulosclerosis (idiopathic)

- Every effort should be made to exclude secondary causes. (R)
- The recommended treatment is corticosteroid given at a single daily dose of 1 mg/kg (maximum 80 mg). (D)
  The initial high dose of corticosteroids should be maintained for a minimum of 4 weeks, and continued for up to 16 weeks, as tolerated, or until CR has been achieved. In patients who remit, corticosteroids should be tapered over a period of up to 6 months following remission.
- For steroid-resistant FSGS, addition of calcineurin inhibitor (cyclosporin or tacrolimus) can be attempted for 4–6 months. (D)
  If there is response to treatment, CNI should be maintained for at least 1 year. Mycophenolate may be an alternative, particularly in patients who are intolerant to CNI. For steroid and CNI/MMF resistant and heavily nephrotic patients, treatment with abatacept (a CTLA-4-Ig fusion protein, a co-stimulatory inhibitor that target B7-1, CD80) may be considered, bearing in mind that mixed results have been reported.[150]

2.3 Membranous nephropathy (idiopathic)

- Every effort should be made to exclude secondary causes. (R)
- Immunosuppressive treatment can be started right away for patients with clinical features of frank nephrotic syndrome. (D)
  Initial therapy should consist of a 6-month course of corticosteroid and cyclophosphamide. Calcineurin inhibitor (cyclosporin or tacrolimus) can be an alternative to cyclophosphamide. Patients who do not respond well to either of these regimens can be crossed over to the other one, that is steroid/CTX to steroid/CNI and vice-versa.[151]
- We suggest not using alternating monthly cycles of intravenous followed by oral corticosteroid and chlorambucil due to the high incidence of side effects. (R)
- For treatment resistant cases, rituximab,[152] a monoclonal antibody against the cell surface antigen CD20 of B cells, or adrenocorticotropic hormone may be considered. (Not Graded)

2.4 Membranoproliferative glomerulonephritis

- Every effort should be made to exclude secondary causes. (R)

- In nephrotic patients, treatment with corticosteroids and oral CTX or MMF should be considered. (D)

2.5 Immunoglobulin A nephropathy

- Patients with isolated microscopic haematuria and normal blood pressure and renal function do not require specific treatment. (R)
- For patients with significant proteinuria, optimization of supportive care, namely RAS blockade, low salt diet and stringent blood pressure control (<130/80 mmHg for proteinuria <1 g/day and 125/75 mmHg for proteinuria >1 g/day), is recommended (R).
  Intensive supportive care has been reported to induce at least partial remission in up to one third of patients in STOP-IgAN.[153]
- Patients with persistent proteinuria ≥1 g/day despite 6 months of optimized supportive care and eGFR >30 mL/min per 1.73 m^2 can be treated with a 6-month course of corticosteroid (D).
  There are mixed results with steroid usage in IgAN. While the recent European STOP-IgAN[153] study showed no effect, the Chinese TESTING study[154,155] demonstrated some anti-proteinuric effects although an untoward side effect profile was observed in the latter study that involved pulse steroid therapy. A retrospective analysis of the European VALIGA cohort suggested that corticosteroid may also be efficacious in IgAN patients with lower GFR.[156] Another European study using an enteric formulation of budesonide also demonstrated significant renoprotective effects after 9 months of therapy.[157]
- For steroid-resistant patients, MMF may be individually considered in Chinese subjects without advanced tubulointerstitial changes,[158–160] but it is not recommended for Caucasians.[161] (Not Graded)
- For IgAN/MCD overlap syndrome, treatment should be analogous to that of MCD (see item 1). (R)
- For crescentic IgAN with clinical features of rapidly progressive glomerulonephritis (RPGN), corticosteroids (intravenous followed by oral) and cyclophosphamide is recommended, analogous to the treatment of ANCA-associated vasculitis (AAV). (D)

There is insufficient evidence to support the use of the following approaches: anti-platelet therapy, fish oil, azathioprine and tonsillectomy.

2.6 ANCA-associated vasculitis

- Initial treatment should consist of pulse corticosteroid and CTX. (R)
  Corticosteroid and rituximab is an alternative for patients in whom CTX is undesirable or ineffective. This stems from initial proof of efficacy of rituximab from small, prospective trials and retrospective surveys conducted in AAV patients with relapsing and refractory disease in which high remission rates allowed reduction of steroid dosages and withdrawal of immunosuppressants. Subsequent randomized trials comparing rituximab versus CTX for inducing remission of new or relapsing AAV led to the licensing of rituximab for this indication.[162]
- Plasmapheresis is desirable for patients with rapidly deteriorating renal function, evidence of pulmonary haemorrhage or overlap syndrome with anti-glomerular basement membrane (GBM) nephritis. (R)
  In a large trial of 137 patients with a new diagnosis of ANCA-associated systemic vasculitis confirmed by renal biopsy and SCr >500 μmol/L, plasma exchange was associated with a reduction in risk for progression to ESRD of 24% (95% confidence interval 6.1–41), from 43% to 19%, at 12 months when compared with intravenous methylprednisolone, though patient survival and severe adverse event rates were similar in both groups.[163]
- Maintenance treatment should consist of corticosteroid and azathioprine. MMF is an alternative. (R)
- Decision on changing immunosuppressive dosage should take into account the clinical picture in addition to the ANCA titre, but not the titre alone. (R)
- Kidney transplantation should be deferred until CR has been achieved for 1 year irrespective of the ANCA titre. (D)

2.7 Anti-glomerular basement membrane disease

- Initial treatment should consist of pulse corticosteroid and CTX plus plasmaphersis. (R)
  Treatment should be commenced as early as possible to reduce the chance of irreversible renal failure. Patients who are already dialysis-dependent on presentation have a poorer renal prognosis and immunosuppressive therapy has to be individualized.
- Kidney transplantation should be deferred until anti-GBM antibodies are undetectable for 1 year. (Not Graded)

2.8 Lupus nephritis

Immunosuppressive treatment for lupus nephritis (LN) includes corticosteroids alone or combined with cyclophosphamide or mycophenolate mofetil. Emerging therapy may even include calcineurin inhibitors and biological agents that target key pathogenetic mechanisms of the disease with the objectives of inducing remission, preserving kidney function and preventing relapses and other complications.[164,165] These latter approaches are not yet fully incorporated into the current guideline due to the paucity of long-term data.

- Treatment decisions for LN are largely dictated by the histological grade of the renal lesion. (R)

- For class I and class II LN with proteinuria below 3 g/day, treatment will be determined in accordance with the extrarenal manifestation of the disease. If proteinuira is >3 g/day, corticosteroids or CNIs may be applied as for MCD (see item 1). (R)
- For class III and class IV LN, initial treatment with corticosteroids combined with either MMF or CTX is recommended. (R)
- Maintenance therapy should include low-dose corticosteroid (e.g. ≤10 mg/day prednisolone) and MMF or azathioprine continued for at least 12 months. (D)
- If there is disease relapse while on maintenance therapy, the dose of immunosuppression can be increased (R).
- If CR is not achieved within 12 months or if there is disease relapse after long periods of quiescence, a repeat renal biopsy is worthwhile to look for a change of histological class of LN. (Not Graded)
- For class V LN, treatment may consist of corticosteroids and any of the following immunosuppressants: CTX, CNI, MMF or azathioprine. (D)
- For class V + IV LN, multi-target therapy consisting of MMF, tacrolimus and corticosteroids may be considered. (Not Graded)
- For treatment of resistant LN not responding to any of the desired protocol, rituximab, IVIg or CNI may be considered. (D)
- In pregnant women, MMF, CTX and RAS blockers should not be used. (R)
- Corticosteroids and hydroxychloroquine can be maintained throughout pregnancy. (D)
- Patients who get pregnant while already on MMF or CTX should be switched to azathioprine. (R)
- Disease flare during pregnancy should be treated with an increased dose of corticosteroids. (D)
- Anti-platelet therapy can be considered for all pregnant patients. (D)

D. AUDIT ITEMS

1. Renal Biopsy

- Number of renal biopsy performed and by whom in the renal unit
- Appropriateness and techniques of biopsy
- Complications-type, rate and need for intervention
- Adequacy of specimen obtained

2. Chronic Kidney Disease

- Blood pressure control
- Glycaemic control in diabetic nephropathy patients
- Appropriate use of ACEI/AII
- Biochemical control-calcium, phosphate, PTH and bicarbonate
- Correction of anaemia and iron status

3. Acute Kidney Injury

- Appropriateness of prophylaxis used for CI nephropathy
- Proportion of patients who receive nephrotoxic drugs
- Types and complications of the dialytic access
- Type and efficacy of anti-coagulation used in the extracorporeal circulation
- Outcome
  - Percentage with residual CKD
  - Percentage requiring RRT within 3–6 months.

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Supplement Article

Clinical practice guidelines for the provision of renal service in Hong Kong: Peritoneal Dialysis

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INTRODUCTION

Peritoneal dialysis (PD) should be an integral part of all renal replacement programmes. Doctors, nurses and paramedical staff should work together as a multidisciplinary team. A unit offering PD should provide not only continuous ambulatory peritoneal dialysis (CAPD) but also machine-assisted automated PD (APD). It should have adequate access to back-up haemodialysis (HD) facilities and renal transplantation.

STRUCTURAL REQUIREMENT

1. SPACE

Guideline statements

1.1 All PD units should have sufficient space to accommodate the relevant personnel and procedures. [R]
1.2 All PD units should have a dedicated area for patient training. [D]

Background

Although PD is a relatively simple technique, it should be performed in the right setting with appropriate facilities. Since there is no randomized control trial in this area, recommendations are based on expert opinion and limited observational data.

Rationale

Guideline 1.1

There is a considerable variation in the scope of service provided by different PD units, and it is unrealistic to dictate a uniform space requirement. In general, PD unit should encompass dedicated PD training rooms, store rooms, clean and dirty utility rooms, clinic area, access to emergency beds and HD, toilet and showers, as well as office for nurse, doctors, clerical and administrative staff.[1]

Guideline 1.2

Good patient training is crucial for the success of all PD programmes.[2] A dedicated area, preferably in the form of a separate room, would facilitate the training procedure and enhance infection control. PD training area should generally include the following equipment: comfortable chairs and beds, wash basins, surface or trolley, weighing scales, drip stands or hooks, shelving for consumables, bag-warming equipment, ambulatory PD machine, clock and sphygmomanometer.[1]

2. EQUIPMENT

Guideline statements

2.1 All equipment used in the delivery and monitoring of therapies should comply with the relevant standards for medical electrical equipment. [R]
2.2 All electromechanical equipment used to undertake PD should comply with international standards for electromechanical safety. [R]

2.3 Fluids for PD should satisfy the current international quality standards. [R]

Background

Equipment for PD is generally simple. Nonetheless, appropriate performance and safety standards should be upheld. Again, there is no randomized control trial in this area. Recommendations are based on the local regulations in Hong Kong as well as guidelines by overseas professional bodies.

Rationale

Guidelines 2.1 to 2.3

The Department of Health of Hong Kong government has a detailed set of regulation is this regard and should be followed.[3] In general, standards recommended by the Renal Association Standards Subcommittee of the Royal College of Physicians should also be followed.[4]

3. HUMAN RESOURCE

Guideline statements

3.1 The PD team should include nephrologists and nurses. The team should also have adequate support from other clinical specialists, such as surgeon, microbiologist, dietitian, social worker, psychologist and rehabilitation specialist. [D]

3.2 The PD team should hold regular scheduled meetings, such as patient-care conferences and quality improvement meetings, to facilitate communication and enhance patient care. [D]

3.3 The PD unit should provide adequate training, including continuing education activity, for medical and nursing staff. [D]

Background

The clinical care and support of PD patient is a team effort. The success of PD as a renal replacement modality is dependent on the commitment and efforts of all members of the PD team. In general, the team usually consists of a central core of health-care providers and a peripheral group of allied specialists.

Rationale

Guideline 3.1

Inadequate staffing ratios of physicians or nurses to patients are likely to be associated with worse clinical outcome.[5] In addition, achieving good clinical governance requires a clearly defined hierarchy of responsibility and an appropriate mix of technical, nursing and medical personnel.[6] The presence of a dedicated nephrologist in a PD programme is of great importance to guarantee success.[7]

Guideline 3.2

Clinical governance is an essential component of a successful PD programme. Regular unit meetings facilitate accountability and internal communication between staff of various expertise.[8] In addition, continuous quality improvement (CQI) programmes are effective in quality assurance as well as improving the outcome of PD patients.[7,9]

Guideline 3.3

Continuous quality improvement programme within a PD unit may help to reduce peritonitis rate.[10] Medical staffs who are committed to the PD programme need to assume leadership roles to ensure professional competence and confidence in PD by establishing appropriate protocols and training curricula, and mandating the provision of continuous education.[6] The latest International Society for Peritoneal Dialysis (ISPD) guideline recommends that multidisciplinary teams running CQI programmes in PD centres should meet and review their units' performance metrics regularly.[11]

4. PROTOCOL

Guideline statements

4.1 There should be written protocols for common standard procedures involved in the care of PD patients. [R]

4.2 Protocols should be developed by medical and/or nursing staff, approved by the nephrologist in-charge of the PD team, and reviewed on a regular basis. [R]

Background

Every clinical procedure should begin with the development of a protocol in order to ensure patient safety and the quality of care. The protocol is a document that describes how a clinical procedure will be conducted, including the objectives, scope of coverage, details of the procedure and methods of outcome evaluation.

Rationale

Guideline 4.1

Creating procedures and training protocols is a critical element of a successful PD programme.[12,13] Infrastructure deficiencies have been proposed as the major reason of unsuccessful PD programme in USA.[14]

Guideline 4.2

The smooth running of a PD programme should be the shared responsibility of the nephrologist in-charge and the PD nurse manager.[1] Preparation of procedure protocols is one of the first steps in PD programme development.[13,15,16] In general, protocols should be evidence-based whenever possible. After the PD programme is successfully underway, periodic review and revision to the protocols are necessary to reflect evolution of clinical practice and to meet regulatory requirements.[17]

Protocols recommended for a PD programme may include, but not limited to, the followings:

a. CAPD exchange procedure (for each system)
b. Cycler set-up procedure (for each cycler)
c. Dialysate and urine collections for adequacy assessment
d. Intermittent PD regimens, for example, intermittent peritoneal dialysis (IPD), continuous cyclic peritoneal dialysis (CCPD)
e. Exit-site care (post-implantation and chronic)
f. Administration of intra-peritoneal (IP) medication
g. Transfer set change procedure
h. Peritoneal equilibration test (PET)
i. Treatment of infections: peritonitis, exit site
j. Managing complications, for example, poor outflow-inflow, crack in catheter

PRE-DIALYSIS CARE

5. PRE-DIALYSIS EDUCATION

Guideline statements

5.1 Patients with advanced CKD should receive timely education about kidney failure and various options for its treatment. [D]

Background

Pre-dialysis education is essential for a patient to make an informed choice of treatment modality. Nonetheless, there are no minimum standards for pre-dialysis education.

Rationale

Guideline 5.1

Multiple studies show that late referral to nephrologist is associated with adverse clinical outcome of dialysis patients.[18] A timely referral means referral to nephrology service at least 1 year before start of dialysis,[19] which allows adequate pre-dialysis education. Pre-dialysis education can be accomplished by a variety of methods, but should be based on principles of adult education with a chronic disease focus.[20] Individual counselling is appropriate for all patients. However, group classes may be helpful for the patient and family members, and allow utilization of staff time more efficiently. Pre-dialysis education programmes are often rewarding and may be valuable for all prospective dialysis patients.[20]

6. INITIATION OF DIALYSIS

Guideline statements

6.1 Initiation of PD could be considered when estimated glomerular filtration rate (eGFR) is ≤10 mL/min per 1.73 m^2 if there is evidence of uraemia or its complications such as malnutrition. [D]
6.2 If there is no evidence of uraemia or its complications, PD should be commenced when eGFR is ≤6 mL/min per 1.73 m^2. [D]

Background

Optimum timing of starting dialysis prevents serious uraemic complications. However, PD has its own risk and complications. As renal function declines, patients and nephrologists must continually consider whether the anticipated clinical benefits of dialysis now outweigh the risks and psychosocial burden of the treatment.

Rationale

Guidelines 6.1 and 6.2

Uraemic symptoms often but not invariably occur in the eGFR range between 5 and 10 mL/min per 1.73 m^2.[19] Survival advantage of early start of dialysis was not confirmed by published trials.[21,22] For example, in the Initiating Dialysis Early and Late Study (IDEAL) study, asymptomatic patients started on dialysis at eGFR 5–7 mL/min per 1.73 m^2 had similar survival with those dialyzed at eGFR 10–14 mL/min per 1.73 m^2.[21] Given the risks and benefits of dialysis, as well as the potential imprecision of measurements, patients need to be treated according to symptoms and signs, not simply based on a laboratory value.[19] On the other hand, some patients are more susceptible to uraemic symptoms, and they may require dialysis at a higher eGFR.

PERITONEAL DIALYSIS EQUIPMENT

7. CATHETER INSERTION

Guideline statements

7.1 Local expertise at individual PD unit should be considered in the choice of method and personnel for PD catheter insertion. [D]
7.2 Prophylactic antibiotics should be administered before PD catheter insertion. [R]

Background

The success of PD hinges upon the presence of a well-functioning PD catheter, which should be inserted by a technique that has proven to reliably lead to a desired result. Attention to details is required to assure the best opportunity for successful insertion of PD catheters.

Rationale

Guideline 7.1

There is no ideal method or personnel for PD catheter insertion. Open mini-laparotomy, blind trocar technique, peritoneoscopic or laparoscopic implantation has all been reported to be successful.[23,24] With appropriate treatment, surgeons, urologists and nephrologists are all capable of performing the procedure.[25,26] Irrespective to the method and personnel, however, the ISPD clinical practice guidelines for peritoneal access should be followed.[27] Nephrologists who perform PD catheter insertion should have the appropriate credentialing as recognized by the Hong Kong College of Physicians.

Guideline 7.2

At least four randomized control trials show that a single dose of preoperative antibiotic given intravenously before PD catheter insertion reduces early peritonitis, but not exit-site and tunnel infection.[28,29] A first-generation cephalosporin (e.g. cefazolin) is the most frequently used agent for this purpose.[30] Vancomycin is the appropriate alternative in case of penicillin allergy or documented carrier of methicillin-resistant *Staphylococcus aureus* (MRSA).

8. BREAK-IN PERIOD CARE

Guideline statements

8.1 Peritoneal dialysis catheter insertion should be performed at least 2 weeks before starting CAPD. [R]
8.2 When there is a clinical need to start PD immediately after catheter insertion, small dialysate volumes in the supine position should be used. [R]

Background

For patients with progressive decline in renal function, the time of initiating dialysis is often predictable. PD catheter insertion should be arranged correspondingly at the outpatient clinic. The objective is to have sufficiently early catheter insertion to enable the patient to train for PD in a timely fashion while residual renal function is sufficient, and to avoid the need for temporary dialysis.

Rationale

Guideline 8.1

Unless there is a pressing clinical need, the wound dressing after PD catheter insertion should be kept undisturbed for at least 48 h in order to allow re-epithelialization. During the process of abdominal wound healing, fibrous tissue deposition takes place from 72 h to 4 weeks.[31] The European best practice guidelines[32] and ISPD guidelines[27] both state that the time between catheter insertion and CAPD beginning should be at least 2 weeks to avoid early leakage.

Guideline 8.2

Recent studies showed that immediate PD after catheter insertion is feasible.[33,34] However, PD with a low volume (1 L cycles for adult patient) in the supine position should be used to minimize mechanical stress to the wound and the risk of dialysate leak.[27,32]

9. TRAINING

Guideline statements

9.1 Training of PD patient should be conducted by renal nurse. [R]
9.2 Each PD unit should develop a specific curriculum for PD training. [R]

Background

Patient training is an essential component of a PD programme. Recommended standards in this aspect have been published by ISPD to guide the education process.[35]

Rationale

Guideline 9.1

High-quality evidence that guides how, where, when and by whom PD training should be performed, however, is lacking. While there are no studies evaluating the education or abilities of the trainer, nursing staff usually take a leading role in coordinating the efforts of the PD team to provide home care for the patients,[36] and are therefore more likely to possess the qualities required for patient training.[35] To successfully teach patients, the nurse must acquire knowledge on education theories and related practical skills.[1] In addition to the initial training, home visit by PD nurses is often useful in detecting practical problems.[37] Re-training in selected patients may also be beneficial.[11] In general, the latest ISPD recommendations for teaching PD patients and their caregivers should be followed.[38]

Guideline 9.2

A formalized programme is the best method to prepare a patient for self-management of any chronic disease.[39] As mentioned in guideline #4.2, a structured protocol, or, in the case of patient training, a detailed curriculum is essential for ensuring the quality of training.[1,13,15,16] Patient education should be documented.[40]

PERITONEAL DIALYSIS ADEQUACY

10. PERITONEAL TRANSPORT TEST

Guideline statements

10.1 Baseline peritoneal membrane transport characteristics should be established 4–8 weeks after initiating PD therapy. [D]

10.2 Peritoneal membrane transport testing should be repeated when clinically indicated. [D]

10.3 All measurements of peritoneal transport characteristics should be performed at least 1 month after resolution of an episode of peritonitis. [D]

Background

There is a substantial inter-individual variation in peritoneal transport characteristics. To optimize solute removal and ultrafiltration volumes, nephrologists must have the information of the peritoneal membrane transport characteristics for each individual patient. The standard PET is easy to perform and most widely used, but other alternative tests may also be acceptable. Our recommendations are largely based on the National Kidney Foundation of United States Kidney Disease Outcomes Quality Initiative (NKF KDOQI) Guidelines.[41]

Rationale

Guideline 10.1

In order to make sensible PD prescription and optimize solute clearance and fluid removal, it is important to determine the peritoneal membrane transport characteristics of each PD patient.[41,42] Baseline peritoneal transport characteristics are particularly important because once established, these data can be used to guide prescription writing and predict clearances and ultrafiltration volumes.[43,44] Kinetic modelling programmes have been developed that use data from the standard PET to help in prescription management.[45,46] However, PET should not be performed sooner than 2 weeks after dialysis commencement because of unstable peritoneal permeability at this stage.[42] The standard PET with 2.5% dextrose solution as described by Twardowski is generally preferred.[47] The modified PET with 4.25% dextrose solution is an acceptable option when ultrafiltration failure is suspected.[48]

Guideline 10.2

Peritoneal transport characteristics may change over time.[49–52] Prolonged PD therapy in itself leads to progressive change in peritoneal transport and ultrafiltration capacity,[49,50] which is often exacerbated following an episode of severe peritonitis.[51] After an episode of severe peritonitis that requires catheter removal and temporary HD, PET should be repeated because peritoneal transport may change drastically and ultrafiltration failure is common.[52] PET should also be repeated when there is clinical suspicion of ultrafiltration failure. In these situations, PET may help to tailor further PD regimen.

Guideline 10.3

PET is not reliable during and shortly after peritonitis episodes. Peritonitis causes peritoneal hyperaemia, which results in transient increase in peritoneal transport of low molecular weight solutes, increase in rates of glucose absorption, and reduction in ultrafiltration.[53] These changes usually resolve within a month after resolution of the peritonitis.[54,55]

11. DIALYSIS ADEQUACY

Guideline statements

11.1 The total (peritoneal and kidney) small-solute clearance should be a total Kt/V(urea) of ≥1.7 per week. [D]

11.2 Total Kt/V(urea) should be measured within 2 months after initiating PD and at least once every 12 months thereafter. [D]

Background

Dialysis adequacy is a broad concept and includes fluid balance, small solute clearance, removal of uremic toxins of middle or large molecular weight and maintenance of nutritional status. Although small solute clearance, as represented by the total clearance of urea, is only one aspect of dialysis adequacy, Kt/V(urea) is a consistent predictor of survival in PD patients,[56] and is therefore an important parameter for monitoring. There is actually insufficient evidence to determine whether achieving a Kt/V(urea) target is more important than achieving a creatinine clearance target. However, there are more studies, more experience and fewer methodological problems with Kt/V(urea).

Rationale

Guideline 11.1

Both local and international studies showed that total Kt/V (urea) below 1.7 is associated with poor clinical outcome of patients treated with CAPD.[56,57] On the other hand, achieving total Kt/V(urea) greater than 1.7 does not result in additional clinical benefits.[58,59] Although renal and peritoneal clearances are probably different biologically, there is no published evidence to guide the minimal target of peritoneal Kt/V. Published data in patients receiving machine-assisted PD are more limited. It is generally believed that the target Kt/V(urea) for machine-assisted PD should be somewhat higher than CAPD, but the exact figure remains to be defined.

Guideline 11.2

There is no available evidence as to the optimal frequency of dialysis adequacy monitoring for patients on PD. The current recommendation strikes a balance between international guidelines[41,42] and practical feasibility in Hong Kong. In addition to the minimal recommendation of yearly measurement, dialysis adequacy measurement should be considered when there is clinical suspicion of under-dialysis, sudden change in peritoneal transport characteristics (e.g. after an episode of severe peritonitis that require catheter removal), or rapid loss of residual renal function.

12. RESIDUAL RENAL FUNCTION

Guideline statements

12.1 Residual kidney function should be measured within 2 months after initiating PD and at least once every 12 months thereafter. [D]

12.2 In the patient with residual kidney function who needs antihypertensive medication, preference should be given to the use of angiotensin converting enzyme (ACE) inhibitors or angiotensin receptor blockers (ARBs). [D]

Background

There is a strong association between residual renal function and clinical outcome of PD patients.[57,60,61] The presence of urine output reduces the risk of fluid overload, facilitate dietary intake and minimize the need of hypertonic PD cycles. Despite a similar degree of small solute clearance, native urine output is superior to dialysis because the clearance of middle or large molecular weight uremic toxin is substantially higher. It is therefore important to monitor and preserve residual renal function.

Rationale

Guideline 12.1

Residual renal function should preferably be measured by 24-h urine collection and calculation of the residual glomerular filtration rate, as represented by the average 24-h urinary urea and creatinine clearances.[62] There is no published evidence as to the optimal frequency of monitoring residual renal function. The NKF KDOQI Guidelines recommend monitoring at least every 2 months,[41] which may not be practical in Hong Kong. Since residual renal function is an integral component of dialysis adequacy assessment, we recommend they should be monitored simultaneously and at the same frequency. Since the urine output of PD patients is often small, collection of 24-h urine output is convenient. More frequent measurement is preferable and probably practical.

Guideline 12.2

Since residual renal function is a strong prognostic indicator for PD patients, its preservation should be a major objective in the management of PD patients.[41] Two randomized control trials consistently showed that the use of ACE inhibitors or ARBs is associated with a reduction in rate of residual renal function decline.[63,64] The use of these agents is therefore recommended when antihypertensive therapy is indicated for PD patients.[41] The use of biocompatible PD solution may also help to preserve residual renal function,[65] but the magnitude of effect is small. There is no definitive evidence that exposure to aminoglycoside accelerates the loss of residual renal function.[66] Nonetheless, nephrotoxic drugs should be avoided.

OTHER CLINICAL TARGET AND MONITORING

13. NUTRITION AND BIOCHEMICAL PARAMETERS

Guideline statements

13.1 Blood pressure and bodyweight should be measured during every clinic visit. [D]

13.2 Serum levels of sodium, potassium, urea, creatinine, albumin, calcium, phosphate, alkaline phosphatase should be measured at least every 3 months. [D]

13.3 Serum parathyroid hormone (PTH) level should be measured at least yearly, and preferably more frequently for patients at risk of hyperparathyroidism (e.g. patients on low calcium dialysate) or those receiving paricalcitol or cinacalcet treatment. [D]

Background

Malnutrition and bone mineral disease are common and important complications of chronic kidney disease (CKD). Although there is no ideal instrument for assessing the nutritional status or bone mineral disease, anthropometric measurements and biochemical tests are readily available and provide valuable information for patient care.

Rationale

Guideline 13.1

Blood pressure and bodyweight measurements are an integral part of primary medical care. Most PD patients are hypertensive; accurate assessment of blood pressure is crucial for patient care.[67] Although office blood pressure may not reliably reflect the overall blood pressure control of a patient,[68] it is the parameter used in almost all antihypertensive trials. Regular self-measurement of blood pressure at home is strongly encouraged. Short-term fluctuations in bodyweight (in days to weeks) often represent change in body fluid status, while the long-term trend (in months) likely reflects alteration in body built and nutritional status.[69] Since blood pressure and bodyweight are non-invasive, they should be measured and documented in every clinic visit.

Guideline 13.2

There is no published data as to the optimal frequency of serum biochemistry monitoring in PD patients. The Caring for Australasians with Renal Impairment (CARI) Guidelines recommend monitoring at least every 2 months.[42] Since most of the stable PD patients in Hong Kong are followed every 2–3 months, our current recommendation represents a compromise between optimal ideal and our local practice. The exact panel of biochemical test depends on local resource as well as individual patient need, but usually includes serum or plasma sodium, potassium, urea, creatinine, albumin, liver enzymes, calcium and phosphate. Fasting plasma glucose and glycated haemoglobin (HbA1c) levels should be measured at least half yearly for diabetic patients. Fasting plasma or serum cholesterol, triglyceride, PTH level and iron profile are also commonly monitored at less frequent intervals.

Guideline 13.3

There is no published data as to the optimal frequency of PTH level monitoring in PD patients. The CARI Guidelines recommend monthly checking when there are changes of therapy that may influence PTH, and every 2–3 monthly in other patients,[70] which may not be possible in Hong Kong. We acknowledge the deficiencies in our current recommendation, which is largely governed by the financial resource and practical feasibility in Hong Kong.

14. HAEMATOLOGICAL PARAMETERS

Guideline statements

14.1 We suggest an haemoglobin target of between 10.0 and 11.5 g/dL. [D]
14.2 In PD patients with anaemia, an erythropoiesis stimulating agent (ESA) should be considered when haemoglobin level is below 9.5 g/dL. [D]
14.3 Haemoglobin level should be monitored at least every 3 months. [D]

Background

Anaemia is an important contributing factor to the poor QOL in CKD patients. Many uremic symptoms, notably malaise and exertional dyspnoea, are directly caused or substantially contributed by anaemia. Persistent anaemia probably contributes to the development of left ventricular hypertrophy and cardiovascular diseases. Although blood transfusion is effective for the treatment of anaemia, regular blood transfusion should be avoided because of the risk of transmitting infections, iron overload and immune sensitization in potential kidney allograft recipients. Since anaemia in CKD is often reversible by ESA treatment, it is important to detect and treat anaemia in all PD patients.

Rationale

Guideline 14.1

Anaemia following dialysis initiation has been shown to be associated with increased mortality in PD patients.[71] International guidelines recommend a very tight Hb range of between 11.0 and 12.0 g/dL.[72,73] However, maintaining Hb levels in such a narrow range is difficult in practice. The CARI guidelines currently recommends a target Hb level of 10.0–11.5 g/dL,[74] which seems a reasonable range, with the consideration of published literature as well as clinical reality.

Guideline 14.2

For any patient who may require ESA therapy, the potential benefits must be balanced with the clinical risks. Iron deficiency (e.g. due to occult blood loss), haemolysis, and other secondary causes of anaemia should be excluded. In anaemic PD patients, the objectives of ESA treatment are to avoid blood transfusion, especially in patients awaiting kidney transplantation, and to improve the quality of life (QOL).[74] There is substantial inter-individual variation in the Hb level that would lead to anaemic symptoms, but non-specific symptoms in patients with Hb above 9.5 g/dL

are unlikely caused by anaemia and ESA would not be beneficial. Patients with underlying coronary artery disease may require a slightly higher haemoglobin level to avoid angina. On the other hand, ESA treatment may be withheld for a lower haemoglobin level in patients with a history of malignancy for the possibility of its trophic effect on tumour growth.

Guideline 14.3

There is no published data as to the optimal frequency of Hb monitoring in PD patients. The CARI Guidelines recommend monitoring at least every 1–3 months.[74] Since Hb level is usually an integral part of regular blood test, we recommend it should be monitored simultaneously with serum biochemistry and at the same frequency.

PERITONEAL DIALYSIS-RELATED INFECTIONS

15. MANAGEMENT OF PERITONITIS

Guideline statements

15.1 Every programme should regularly monitor infection rates, at a minimum, on a yearly basis. [R]

15.2 PD patients presenting with cloudy effluent should be presumed to have peritonitis, which should be confirmed by obtaining effluent cell count, differential and culture. [D]

15.3 Empiric antibiotic therapy should be initiated as soon as possible after a working diagnosis of PD-associated peritonitis is made. [D]

15.4 Empiric antibiotic therapy should cover both Gram-positive and Gram-negative organisms; IP administration of antibiotics is preferred. [D]

15.5 Once culture results and sensitivities are known, antibiotic therapy should be adjusted to narrow spectrum agents as appropriate. [D]

15.6 The minimum therapy for peritonitis is 2 weeks, although 3 weeks is recommended for episodes caused by *Staphylococcus aureus*, *Pseudomonas* species or clinically severe infections. [D]

15.7 PD catheter removal should be considered for relapsing peritonitis, refractory peritonitis, fungal peritonitis or refractory catheter infections. [D]

Background

Peritonitis is a major complication of PD. Although less than 4% of the peritonitis episodes resulted in death, peritonitis is a contributing factor to death in 16% of deaths on PD. In addition, peritonitis is the most common cause of ultrafiltration problem and technique failure in PD. The ISPD has published detailed recommendations on the treatment of PD-related peritonitis,[11,75] which should be followed as much as practically feasible.

Rationale

Guideline 15.1

A previous observational study showed that CQI programmes with regular monitoring effectively reduces peritonitis rate.[9] This practice is endorsed by the latest ISPD recommendations.[11] Peritonitis rate should be reported as the number of episodes per patient-year rather than number of patient-month per episode,[11] which was commonly used in the past. In addition to the overall peritonitis rate, PD centre should ideally monitor the peritonitis rates of specific organisms, the percentage of patients per year who are peritonitis free, and the antimicrobial susceptibilities of the infecting organisms.[11] Organism-specific peritonitis rates should also be reported as absolute rates, that is, as number of episodes per year. Sampling and culture methods of PD effluent should be reviewed and improved if more than 15% of peritonitis episodes are culture-negative.[11]

Guideline 15.2

Patients with peritonitis usually present with cloudy fluid and variable degree of abdominal pain.[11,76] For the purpose of unit audit, peritonitis should be diagnosed when at least 2 of the following are present: (i) clinical features consistent with peritonitis, that is, abdominal pain and/or cloudy dialysis effluent; (ii) dialysis effluent white cell count greater than 100/μL or greater than 0.1×10^9/L (after a dwell time of at least 2 h), with greater than 50% polymorphonuclear neutrophil and (iii) positive dialysis effluent culture.[11] However, cloudy PD effluent almost always represents infectious peritonitis although there are other causes.[11,77,78] Since early effective treatment is critical for therapeutic success, PD patients presenting with cloudy effluent should be presumed to have peritonitis and treated as such until the diagnosis can be confirmed or excluded. When a patient presents with cloudy PD effluent or whenever peritonitis is suspected, PD effluent should be tested for cell count, differential, Gram stain and culture. Blood-culture bottle is the preferred technique for bacterial culture of PD effluent.[11] Centrifuging PD fluid and culturing the pellet, or the lysis centrifugation technique may further improve the diagnostic yield. There is insufficient evidence to currently support the use of novel techniques for the diagnosis of peritonitis.

Guideline 15.3

There are potentially serious consequences of peritonitis (relapse, catheter removal, permanent transfer to HD and death), which are more likely to occur if treatment is not promptly initiated. To prevent delay in treatment, antibiotic

therapy should be initiated as soon as cloudy effluent is seen, without waiting for confirmation of the cell count from the laboratory.[11]

Guideline 15.4

Since delayed effective treatment is associated with serious consequences (see above), it is important for the antibiotic protocol to cover all pathogens that are likely to be present. No antibiotic regimen has been proved to be superior to the others as empirical treatment. The selection of empiric antibiotics must be made in light of both the patient's and the programme's history of microorganisms and sensitivities.[79] In general, Gram-positive organisms may be covered by vancomycin or a cephalosporin, and Gram-negative organisms by a third-generation cephalosporin or aminoglycoside.[11] Vancomycin is often not preferred for empirical Gram-positive coverage because of the worry of inducing vancomycin resistant organisms, except in PD units with a high prevalence of methicillin-resistant bacteria. Aminoglycosides and ceftazidime have similar efficacy as empirical Gram-negative coverage. There is no evidence that short courses of aminoglycosides accelerate the loss of residual renal function, but repeated or prolonged aminoglycoside treatment (more than 3 weeks) should be avoided.

Intra-peritoneal antibiotics are the preferred route of administration unless the patient has features of systemic sepsis.[11] IP aminoglycoside should preferably be administered as daily intermittent dosing. IP vancomycin should be administered intermittently every 4–5 days. Since the dosage interval varies with bodyweight and residual renal function, measurement of serum vancomycin level may help the clinical decision, and serum vancomycin level should be kept above 15 μg/mL.[11] IP cephalosporin may be administered either continuously or on a daily intermittent basis, although continuous dosage is preferred for pharmacokinetic considerations.

Guideline 15.5

Within 48 h of initiating therapy, most patients with PD-related peritonitis should have considerable clinical improvement.[11] It is good clinical practice to avoid continuing unnecessary broad spectrum antibiotics in order to avoid the emergence of resistant organisms.[80]

Guideline 15.6

Although there is no randomized control trial in this area, clinical experience and the latest ISPD guideline recommend treatment of 2 weeks as the minimal duration.[11] Published series suggest that peritonitis episodes caused by *Staphylococcus aureus* or *Pseudomonas* species have an increased risk of developing relapsing episodes and may be benefited from a longer duration of therapy.[81,82] Patients who responded slowly to antibiotics, as well as those with severe peritonitis, especially episodes caused by *Enterococcus* species or mixed bacterial growth, may also be benefited from a longer course of treatment.

Guideline 15.7

The focus of peritonitis treatment should always be on preservation of the peritoneum rather than saving the peritoneal catheter.[11] Recurrent or prolonged inflammation of the peritoneum results in the loss peritoneal space and semipermeable property.[49,52,83] Bacterial biofilm adhering on the PD catheter is an important cause of refractory peritonitis (defined as failure of the PD effluent to clear up after 5 days of appropriate antibiotics), relapsing episodes, as well as recurrent exit-site or tunnel infections.[84,85] Timely catheter removal is therefore crucial for the eradication of these infections. Published series suggest that fungal peritonitis episodes generally have a poor response to anti-fungal therapy without catheter removal.[86,87] After catheter removal, the effective antibiotics should be continued for at least two further weeks.[11] It is often appropriate to consider returning to PD after catheter removal and a minimum of 2–3 weeks of temporary HD.

16. MANAGEMENT OF EXIT-SITE AND TUNNEL INFECTION

Guideline statements

16.1 Oral antibiotic therapy is generally recommended for the treatment of exit-site or tunnel infection, with the exception of infections caused by MRSA or by organisms resistant to oral antibiotics. Intravenous antibiotics should be considered for severe tunnel infection. [D]

Background

Catheter-related infections are used as the collective term to describe both exit-site infection (ESI) and tunnel infection, which may occur on their own or simultaneously. An ESI is defined by the presence of purulent drainage, with or without erythema of the skin at the catheter-epidermal interface. A tunnel infection may present as erythema, oedema or tenderness over the subcutaneous pathway but is often clinically occult. A tunnel infection usually occurs in the presence of an ESI but rarely occurs alone. In general, nephrologists should follow the latest ISPD recommendations on the treatment of exit-site and tunnel infections.[88] Each PD unit should ideally monitor the incidence of catheter-related infections, at least on a yearly basis.

Rationale

Guideline 16.1

During exit-site or tunnel infection, the exit site should be cleansed at least daily.[88] Since exit-site and tunnel infections often lead to subsequent peritonitis, they should be promptly identified and aggressively treated. The most serious and common pathogens are *Staphylococcus aureus* and *Pseudomonas aeruginosa*, which could be treated effectively on an out-patient basis with oral penicillinase-resistant (or broad spectrum) penicillin and fluoroquinolone, respectively.[88,89] Most ESI should be treated with at least 2 weeks of effective antibiotics, but ESI caused by *Pseudomonas* species or tunnel infection should be treated with at least 3 weeks.[88] Refractory exit-site or tunnel infection is defined as failure to respond after 3 weeks of effective antibiotic therapy; simultaneous removal and re-insertion of the dialysis catheter with a new exit site under antibiotic coverage should be considered.[88] A number of other interventions have been tried for the treatment of chronic or refractory catheter infections, but their evidence is limited.

17. PREVENTION OF PD-RELATED INFECTIONS

Guideline statements

17.1 Systemic prophylactic antibiotics should be administered immediately prior to the insertion of PD catheter. [R]

17.2 If nasal carriage of *S. aureus* is found in PD patients, eradication should be attempted by appropriate treatment. [D]

17.3 Systemic antibiotic prophylaxis should be administered before colonoscopy or invasive gynaecologic procedures in PD patients. [R]

17.4 Fungal prophylaxis with oral nystatin during antibiotic therapy for bacterial peritonitis episodes should be considered. [D]

Background

For a PD programme to be successful, close attention must be paid to prevent PD-related infections, which include peritonitis, ESIs, and tunnel infections. ISPD has published a position statement on the prevention of PD-related infections,[11,30,88] which should be followed as much as practically feasible. Notably, exit-site and catheter tunnel infections are major predisposing factors to PD-related peritonitis.

Rationale

Guideline 17.1

The overall benefit of prophylactic perioperative intravenous antibiotics is supported multiple randomized control trials.[29] Although first-generation cephalosporin may be slightly less effective than vancomycin, the former is still commonly used because of the concern regarding vancomycin resistance. Current evidence does not support the use of any specific insertion technique, catheter design or PD solution for the prevention of peritonitis or catheter-related infections. Disconnect PD systems with a 'flush before fill' design results in a lower peritonitis rate as compared with the traditional spike systems,[11] but spike systems are no longer routinely available for clinical use.

Guideline 17.2

Staphylococcus aureus peritonitis and ESI are associated with nasal carriage.[90] Although there is no good randomized study to support routine screening of nasal *S. aureus* carriage in PD patients, this practice is easy to execute and facilitate the infection control procedures within hospital. The efficacy of prophylactic intra-nasal antibiotics, especially intra-nasal mupirocin, for the treatment of nasal carriage of *S. aureus* has been shown to reduce the risk of catheter-related infections, but the effect on peritonitis rate is less clear.[29,91,92] Cyclical oral rifampicin therapy (typically 5 days course every 3 months) is also effective in reducing the rate of catheter-related infections, but the routine use of oral rifampicin for prophylactic purpose should not be recommended because adverse reactions, drug interaction and rifampicin resistance are all important problems. There are also good data to support the use of PD catheter exit-site antibiotic cream (either mupirocin or gentamicin) in all patients,[30,91,93,94] but emergence of resistant organisms is a concern when the use of topical antibiotic is prolonged and across the board.[95,96]

Guideline 17.3

Invasive interventional procedures (e.g. colonoscopy, hysteroscopy, cholecystectomy) frequently cause peritonitis in PD patients.[97] Several studies confirm that intravenous antibiotic prophylaxis before invasive gastrointestinal (GI) procedures reduces early peritonitis in these patients.[29] The optimal antibiotic regimen is not well defined, but previous systematic review recommended the use of intravenous ampicillin plus an aminoglycoside, with or without metronidazole, for this purpose.[29]

Guideline 17.4

Most of the fungal peritonitis episodes are preceded by courses of antibiotics, often for the treatment of bacterial peritonitis episodes.[98] A number of observational studies and randomized trials have shown that oral nystatin significantly reduces the risk of secondary fungal peritonitis following antibiotic therapy.[29,99,100] Oral fluconazole is also effective for this indication,[101] but there are potential

problems (e.g. drug interactions, emergence of resistant strains) with fluconazole prophylaxis so that it is not routinely recommended.

ACUTE PERITONEAL DIALYSIS

Guideline statements

18.1 Acute PD is a valid option of renal replacement therapy in acute kidney injury (AKI). [D]
18.2 Nephrologists should receive training and be permitted to insert acute PD catheters. [D]

Background

In the past 20 years, renal support for AKI was largely provided by extracorporeal blood-based therapy. However, there are clinical circumstances where acute PD may be a more appropriate modality of temporary dialysis. In fact, acute PD was initially used in the 1920s for the treatment of AKI and was not uncommonly life-saving. Nephrologists should refer to the recent ISPD guidelines for the recommended practice of PD for the treatment of AKI.[102]

Rationale

Guideline 18.1

Acute PD has many potential advantages over extracorporeal dialysis for temporary renal support.[103] Data on acute PD in AKI are summarized in a recent systematic review.[104] After reviewing 24 studies with over 1500 patients, it was concluded that there is currently no evidence to suggest significant differences in mortality between acute PD and extracorporeal blood purification in AKI.[104] As compared with other blood-based extracorporeal renal support, acute PD should particularly be considered in patients who are hypotensive, have contraindications to systemic anticoagulation, or have limited vascular access.

Guideline 18.2

There is little difference in outcomes between various methods of acute PD catheter insertion.[105,106] The ISPD guidelines on peritoneal access recommend that the method of insertion should depend on expertise at the centre.[27] To ensure timely dialysis in the emergency setting, the current ISPD guideline emphasizes the need of, with the appropriate training, allowing nephrologists to insert acute PD catheters.[102]

Limitations

Published clinical trials are limited in many of the areas presented. Notably, the recommendations on space, equipment and human resource requirement are largely opinion-based. On the other hands, recommendations on pre-dialysis care, patient training, dialysis adequacy, management of PD-related infections and acute PD are based on review of selected publications rather than thorough review of all published literature because of practical limitations. We also pay particular attention to published guidelines by other professional bodies. However, many a time our recommendations are different from international guidelines after considering local practice and practical feasibility in Hong Kong. We are aware of the deficiencies in our recommendations.

Implementation issues

Strict following of the above recommendations may be difficult when the resources are limited. Given the shortage of nephrologists and renal nurses, as well as the increasing numbers of PD patients, both health-care providers and administrators need to be flexible in following the recommendations while still upholding a minimal standard of quality of care.

AUDIT ITEMS

PD practice patterns vary considerably between individual units. Steps to address identified gaps in treatment outcomes include the agreement on and monitoring of uniform key performance indices.

Standards of PD care in different PD units can be assessed by the use of a uniform set of key performance indices (KPIs). Three major categories of KPIs for benchmarking PD practice have been described:

1. clinical outcome indicators (e.g. survival rates)
2. process indicators (e.g. Kt/V(urea), Hb level)
3. infrastructure and manpower distribution indicators

For each PD unit, these results should be benchmarked against international guideline standards in order to achieve the best possible results with PD therapy.

For all PD units, we recommend at least yearly audit of the following indices:

- Patient survival at 1, 3 and 5 years
- Non-death censored technique survival at 1, 3 and 5 years
- Peritonitis rate (number of episodes per patient-year)
- ESI rate (number of episodes per patient-year)
- Culture-negative peritonitis rate
- Percentage of patients with total Kt/V(urea) ≥ 1.7
- Percentage of patients with Hb in range of 10.0–11.5 g/dL

Abbreviations

ACE angiotensin converting enzyme
AKI acute kidney injury

APD	machine-assisted automated peritoneal dialysis
ARB	angiotensin receptor blockers
CAPD	continuous ambulatory peritoneal dialysis
CARI	Caring for Australasians with Renal Impairment
CCPD	continuous cyclic peritoneal dialysis
CKD	chronic kidney disease
CQI	continuous quality improvement
eGFR	estimated glomerular filtration rate
ESA	erythropoiesis stimulating agent
GI	gastrointestinal
Hb	haemoglobin
HD	haemodialysis
IDEAL	Initiating Dialysis Early and Late Study
IPD	intermittent peritoneal dialysis
ISPD	International Society for Peritoneal Dialysis
KDOQI	Kidney Disease Outcomes Quality Initiative
KPI	key performance index
MRSA	methicillin-resistant *Staphylococcus aureus*
NKF	National Kidney Foundation of United States
PD	peritoneal dialysis
PET	peritoneal equilibration test
PTH	parathyroid hormone
QOL	quality of life

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Supplement Article

Clinical practice guidelines for the provision of renal service in Hong Kong: Haemodialysis

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1. WATER TREATMENT SYSTEM, HAEMODIALYSIS (HD)/ HAEMODIAFILTRATION (HDF) MACHINES

1.1 Water treatment system and distribution loop

Guideline statements

1.1.1 Disinfection procedure guidelines for reverse osmosis (RO) machine and loop (as recommended by manufacturer). (R)

1.1.2 Written documentation of absence of disinfectant for RO and loop post disinfection. (R)

1.1.3 Daily recording of RO operational parameters, including pressures, incoming water temperature, rejection rate of RO water. (R)

1.1.4 Central station monitoring or alarm system for water treatment plant. (D)

1.2 HD/HDF machine

Guideline statements

1.2.1 Procedure guidelines on preparation of the machine for HD/HDF. (R)

1.2.2 Procedure guidelines for putting patient on HD/HDF. (R)

1.2.3 Procedure guidelines for taking patient off HD/HDF. (R)

1.2.4 Guidelines on disinfection and aftercare of HD/HDF machine. (R)

1.2.5 Documentation for absence of residual disinfectants for machines requiring manual chemical disinfection. (R)

1.2.6 Documentation of water quality according to the guideline 2. (R)

1.3 Occupational safety

Guideline statements

1.3.1 Infection control guidelines regarding handling of body fluids, handling of spills and decontamination procedures, sharps disposal and contingency plan on exposure of needle stick injury. (R)

1.3.2 Guidelines on proper handling of disinfectants and decontamination facilities for accidental spills. (R)

1.3.3 Appropriate personal protect equipment should be provided for staff handling the disinfectants. (R)

1.4 Contingency

Guideline statements

1.4.1 Contingency guidelines for suspension of water, electricity supply and fire hazard. (R)

1.4.2 Clinical guidelines for patient's management on exhibition of the symptoms of disinfectant toxicity. (R)

1.4.3 Resuscitation guidelines. (R)

1.5 Maintenance and repair work

Guideline statements

1.5.1 Guidelines on repair of RO. (R)

1.5.2 Notification and written documentation on the completion of maintenance/repair work of RO. (R)

1.5.3 Service/maintenance record of all electronic/electric dialysis equipment. (R)

Background and rationale

Guidelines 1.1.1 to 1.5.3

The guidelines are modified from existing recommendations[1] and should be in place for safe operation of the water treatment system and HD machine.

Audit items

Safety procedure checklist and procedure guidelines for water treatment system and dialysis equipment.

2. WATER QUALITY

2.1 Method of testing

Guideline statements

2.1.1 For culture, total viable counts (colony-forming units (CFU)) should be tested by the membrane filtration, spread plate or pour plate technique using Tryptone Glucose Extract Agar (TGEA), Reasoner's Agar 2A (R2A) or equivalent culture medium. (R)

2.1.2 Endotoxin should be tested using the limulus amoebocyte lysate (LAL) method. (R)

2.2 Quality of RO water used for preparation of dialysis fluid

Guideline statements

2.2.1 Sample should be collected from a point in the distal segment of the loop, immediately prior to where water returns to the RO, or immediately prior to where the water re-enters the storage tank, if one is present. (R)

2.2.2 Measurements of the inorganic contaminants (Table A1) should be done at least annually by accredited laboratories. (R)

2.2.3 Microbiological quality of the RO water should be <100 CFU/mL for bacteria and <0.25 endotoxin units (EU)/mL for endotoxin. (R)

2.2.4 If the bacterial count is ≥50 CFU/mL or the endotoxin level is ≥0.125 EU/mL, disinfection and retesting should be commenced immediately. (R)

2.2.5 Monitoring of the microbiological quality of the RO water should be done at least monthly. (R)

2.3 Quality of dialysis fluid for low-flux HD, high-flux HD and HDF

Guideline statements

2.3.1 Sample should be collected at the inlet line of the dialyzer. (R)

2.3.2 For HD using low flux membranes, the microbiological quality of the dialysis fluid should be <100 CFU/mL for bacteria and <0.5 EU/mL for endotoxin. (R)

2.3.3 If the bacterial count is ≥50 CFU/mL or the endotoxin level is ≥0.25 EU/mL, disinfection and retesting should be commenced immediately. (R)

2.3.4 For HD using high flux membranes (also known as high-flux HD), the microbial standards same as that for HDF is highly desirable (guideline 2.3.5). (D)

2.3.5 For HDF, the microbiological quality of the dialysis fluid should be <0.1 CFU/mL for bacteria and <0.03 EU/mL for endotoxin (also known as ultrapure dialysis fluid). (R)

2.3.6 Monitoring of the microbiological quality of the dialysis fluid should be done at least monthly, rotated among machines so that each machine is tested at least once per year. (R)

2.4 Quality of substitution fluid for online HDF and haemofiltration

Guideline statements

2.4.1 Sample should be collected from the replacement line. (R)

2.4.2 Microbiological quality of the substitution fluid should be <0.1 CFU/mL for bacteria and <0.03 EU/mL for endotoxin. (R)

2.4.3 Monitoring of the microbiological quality of the substitution fluid should be done at least monthly on every machine. (R)

Background and rationale

Quality of drinking water unlikely fulfills all the ANSI/AAMI/ISO standards and should be treated before it is safe to prepare the dialysis fluid. In Hong Kong, the higher total chlorine and fluoride levels in drinking water are intended for prevention of bacterial growth and dental protection, respectively[2,3] (Table A1). On the other hand, a higher nitrate level may reflect the use of synthetic nitrogen fertilizers and livestock manure in agriculture as around 70%–80% of the drinking water is from Dongjiang.[4,5]

Dialysis fluid, prepared by mixing the RO water and dialysate concentrates, is an essential component in HD and related therapies. The water for reprocessing dialyzers, the substitution fluid for online HDF and haemofiltration is also produced from the RO water. Any chemical or microbiological contaminants in the RO water, dialysis fluid and substitution fluid could cause serious and even fatal consequences.

The rationale for the development of these guidelines is to set standards for known chemical and microbiological contaminants in the treated water, dialysis and substitution fluids, and to protect patients from adverse events arising from these contaminants. Some of these guideline statements are made reference to the existing guidelines.[6,7]

Use of ultrapure dialysis fluid is highly desirable for high-flux HD because of the concern of back-transport phenomena. There is increasing evidence that use of ultrapure dialysis fluid decreases markers of inflammation and oxidative stress, increases serum albumin, lessens anaemia, decreases erythropoietin requirement and preserves residual renal functions.[8,9] Moreover, high flux HD using an ultrapure dialysis fluid is found to have better cardiovascular event-free survival and overall survival.[10] Finally, guidelines supporting the regular use of ultrapure dialysis fluid for all HD modalities have also been published.[11–14]

Sterile fluid should contain bacterial count $<10^{-6}$ CFU/mL and endotoxin <0.03 EU/mL. Such criteria should apply to the online-produced substitution fluid for HDF or haemofiltration. However, bacterial count of $<10^{-6}$ CFU/mL cannot be demonstrated by culture method unless sample volume up to 1000 L is collected. Because of this, the recommended microbiological standards for substitution fluid are same as those for ultrapure dialysis fluid for practical reason.

There is recommendation that monitoring of the microbiological quality for the online produced substitution fluid is not necessary if the source fluid is of an ultrapure quality and the production path are fitted with a bacteria- and endotoxin-retentive filter validated by the manufacturer and operated and monitored according to the manufacturer's instructions.[6,7] Given the increasing interest in high volume HDF in which large volume of substitution fluid infuses directly into patient's blood stream, the workgroup would adopt a more stringent approach and recommend monitoring to ensure quality of the substitution fluid. It should be noted that quality of the online produced fluid depends on integrity of the bacteria- and endotoxin-retentive filters and performance of the filters might be affected by different disinfection methods.[15] Moreover, it has been reported that a small but significant number of dialysis fluid and substitution fluid samples failed to meet the standards even the manufacturers' instructions were followed.[16]

Audit items

Water/dialysis fluid/substitution fluid quality

Bacterial counts, endotoxin levels, test frequency and results.

3. BIOMEDICAL EQUIPMENT

3.1 HD machines

Guideline statements

3.1.1 Equipment should have facilities for producing bicarbonate-based dialysis fluid and for volumetric control of ultrafiltration. (R)

3.1.2 Each dialysis unit is recommended to use similar brands/models of HD machines from the same manufacturer to facilitate maintenance, smooth dialysis operation and to avoid confusion in the stock of different varieties of dialysis consumables. (D)

3.1.3 It is also desirable to acquire the water treatment system and the HD machines supplied by the same manufacturer to facilitate auto-disinfections of the distribution system and HD machines. (D)

3.1.4 It is suggested that machines should be replaced after between 7 and 10 years' service or after completing between 25 000 and 40 000 h of use for HD, depending upon an assessment of machine condition or the manufacturer recommendation. (D)

Background and rationale

The guidelines are modified from existing recommendations.[1,14] There is no strong evidence that a HD machine needs to be replaced after a certain year of service or service hours. There is, however, evident that the time between machine failures is much shorter for the older machines. A structural approach to machine replacement could avoid unexpected service interruption as well as possibility of obsolete spare parts for old models.

4. BIOCOMPATIBILITY ISSUES

4.1 Dialysis fluids

Guideline statement

4.1.1 Bicarbonate dialysis solution is the fluid of choice. (R)

Background and rationale

Bicarbonate is generally well tolerated, without the haemodynamic instability that may occur with acetate. The use of acetate-based dialysis fluid is now considered obsolete in most countries.[19]

4.2 Dialysis membranes

Guideline statements

4.2.1 Use of biocompatible membranes is recommended for HD. (R)

4.2.2 Either low-flux or high-flux membranes can be used for HD. (R)

Background and rationale

The primary findings of three large randomized controlled trials – HEMO Study, Membrane Permeability Outcome (MPO) trial and EGE Study – showed no survival benefit with high-flux over low-flux dialyzers.[10,20,21] In the HEMO Study, there was no significant effect of high-flux *versus* low-flux membranes on the primary end-point of all-cause mortality. However, high flux was associated with a significant reduction in several secondary outcomes, including cardiac mortality and a composite outcome of cardiac hospitalization or cardiac death. A post hoc analysis showed that patients treated with dialysis for more than 3.7 years prior to randomization had a lower risk of death with high-flux *versus* low-flux dialyzers.[21] In the MPO trial, the primary analysis showed no significant difference in mortality with high-flux *versus* low-flux membranes. However, a subgroup analysis showed that there was a statistically significant reduction in all-cause mortality in the high-flux *versus* the low-flux group among patients with serum albumin ≤40 g/L. Post hoc subgroup analyses also demonstrated improved survival associated with high-flux *versus* low-flux dialyzers among those with diabetes.[20] In the EGE Study, there was no statistically significant difference in the primary outcome between high-flux and low-flux dialyzers. However, a post hoc analysis suggested a benefit associated with high-flux *versus* low-flux dialysis on improving cardiovascular event-free survival among those with diabetes.[10] From these results, the Work Group opines that high-flux dialyzers should be used preferentially, and patients with lower serum albumin, longer dialysis vintage, or diabetes should be considered a priority for selection of high-flux dialyzers.

4.3 On-line HDF

Guideline statement

4.3.1 On-line HDF is an alternative choice of treatment to conventional HD in chronic HD patients. (R)

Background and rationale

Of the seven randomized controlled trials comparing on-line HDF to either low-flux[22–24] or high-flux HD,[25–28] only one trial, the ESHOL study, showed significantly reduced all-cause and cardiovascular mortality with on-line HDF compared with high-flux HD.[26] The other six trials including the CONTRAST Study,[22] the Turkish OL-HDF Study[25] and the recent FRENCHIE Study[28] found no benefit of on-line HDF on mortality. One pooled individual participant data analysis from four randomized-controlled trials on the effects of on-line HDF *versus* conventional HD indicates on-line HDF reduces the risk of mortality in patients with end stage renal disease,[29] while two other meta-analyses did not show benefit of convective dialysis on mortality.[30,31] For the relation between convection volume of HDF and mortality, survival benefit was observed in DOPPS patients with a substitution volume >15 L per session.[32] The CONTRAST Study has showed that the hazard ratio of all-cause mortality was considerably lower in the patient group treated with the highest delivered convective volumes (>21.95 L).[22] In a post hoc analysis in the Turkish OL-HDF Study, the subgroup of OL-HDF patients treated with a median substitution volume >17.4 L per session had better cardiovascular and overall survival compared with the high-flux HD group.[25] Similarly, the post hoc analysis in the ESHOL study showed a 40% and 45% mortality risk reduction in patients receiving convection volumes between 23–25 and >25 L/session, respectively.[26] From these results, it seems that achieving higher convective volume is associated with better survival in on-line HDF treatment. Nevertheless, further large-scale studies are needed before on-line HDF can be recommended *versus* conventional HD.

5. CLINICAL STANDARD AND TARGETS

5.1 Monitor adequacy of dialysis

5.1.1 Methods for measuring HD dose

Guideline statements

5.1.1.1 Kt/V for urea is used to quantify HD dose. (R)

5.1.1.2 The preferred method for Kt/V measurement is the Daugirdas second generation equation. (D)

5.1.1.3 On-line clearance measurement is an alternative method for measurement of HD dose. (D)

5.1.1.4 HD dose should be measured at least every 3 months. (D)

Background

Outcome studies have shown a correlation between the delivered dose of HD, and mortality and morbidity of patients with end-stage renal disease.[33–38] Therefore, delivered dose of dialysis should be measured in patients on chronic HD.

Rationale

Guideline 5.1.1.1

Clinical signs and symptoms, blood urea and creatinine levels are not reliable indicators of dialysis adequacy. The dose of HD is best to be expressed as K*t*/*V*. Since HD most effectively removes small solutes, urea K*t*/*V* is a sensitive measure of dialysis dose. K is the effective dialyzer urea clearance, *t* is the time measured from the beginning to the end of dialysis and *V* is the volume of urea distribution. It is a measure of clearance per dialysis session factored for patient size, measured as *V*.

Guideline 5.1.1.2

The best method for K*t*/*V* measurement is formal urea kinetic modelling (UKM) which gives a single pool, variable volume mathematical analysis for quantitation of urea removal during a single HD session.[39,40] However, due to the complexity of the formulae, computer software is required to calculate the value of K*t*/*V*. Also, formal UKM requires three measurements of blood urea level, the pre-dialysis and post-dialysis urea levels for the first dialysis session and the pre-dialysis urea level for the second dialysis of the week. A simplified equation – the Daugirdas second generation equation – is the best alternative formula for calculation of K*t*/*V*. The value obtained by this formula is single-pool K*t*/*V* (spK*t*/*V*)[41]:

$$spKt/V = -ln(R - 0.008 \times t) + (4 - 3.5 \times R) \times UF/W$$

where R is the post-/pre-dialysis blood urea level, t is the dialysis session length in hours, UF is the ultrafiltration volume in litres and W is the post-dialysis bodyweight in kilograms. This formula accounts for the effect of urea generation during dialysis and the effect of contraction of body water volume during dialysis. It can be used across a wide range of K*t*/*V* values (0.7–2.0) with little systematic error.

Guideline 5.1.1.3

On-line urea clearance

Dialysate conductivity measurements allow automated on-line estimation of urea clearance and HD adequacy during HD. A value of effective dialysance can be measured by a temporary change in concentration of the dialysate delivered to the dialyzer[42,43] and effective dialysance is the dialysance taking into account access recirculation (AR) and cardiopulmonary recirculation (CAPR).[43] Since the conductivity of a solution is related to its electrolyte concentration, it is feasible to substitute conductivity measurements for concentration measurements. The value of effective dialysance obtained from these conductivity measurements is called 'ionic dialysance'. It has been shown that sodium clearance is equal to urea clearance.[44] Since sodium chloride is the major salt in the dialysate, it contributes more than 95% of the electrolyte conductivity of dialysate. Sodium clearance can be calculated from dialysate conductivity measurements which can be done automatically with on-line conductivity meters placed in the inlet and outlet dialysate streams. With this effective conductivity clearance or the ionic dialysance value, K*t*/*V* can be automatically computed by the HD machine that is equipped with on-line clearance monitoring (OCM).

This method has been shown to have high degree of correlation with Kt/V measured by urea reduction in a number of studies.[45–47] This method does not require blood sampling and can be used with each dialysis treatment. However, more recent studies has shown that Kt/V OCM with V determined by Watson formula, leads to systematic underestimation of Kt/V by 22%–24% when comparing to Kt/V derived from urea reduction using the Daugirdas second generation equation.[48–50]

5.1.2 Methods for post-dialysis blood sampling

Guideline statements

5.1.2.1 The pre-dialysis urea sample must be taken before dialysis is started and dilution of pre-dialysis urea sample with saline or heparin must be avoided, because underestimating the pre-dialysis urea level will result in underestimation of Kt/V. (R)

5.1.2.2 Obtain post-dialysis urea sample using the slow-blood-flow method to ensure that the blood sample contains no recirculated blood due to access recirculation. The Kt/V calculated from this post-dialysis urea sample is regarded as spKt/V. (R)

Background and rationale

Guideline 5.1.2.1

The pre-dialysis urea sample must be taken before dialysis is started to prevent this sample from reflecting any impact of dialysis. Dilution of the pre-dialysis sample with saline or heparin should be avoided. Underestimating the pre-dialysis urea level will result in underestimation of Kt/V.[51]

Guideline 5.1.2.2

Proper timing for post-dialysis urea sampling is critical.[52,53] Immediately after completion of HD, if AR is present, some of the blood remaining in the access and extracorporeal circuit actually is recirculated blood. If the blood sample is drawn immediately after completion of dialysis, the just-dialyzed blood that has recirculated into the access will present in sample. The consequence of sampling this admixture is a falsely low urea value and artificially elevated Kt/V.[52,53] Therefore, the amount of dialysis delivered will be overestimated.

Early urea rebound, which occurs within 3 min after dialysis, has two components.[54–56] The first component is caused by blood recirculation within the access and is not present in patients without AR. If AR is present, urea rebound from recirculation begins immediately upon

Table 1 Slow-blood-flow method for obtaining the post-dialysis sample

a. Drawing the sample from the blood line sampling port
   i. At the completion of HD, turn off the dialysate flow and decrease the UFR to 50 mL/h, to the lowest TMP/UFR setting, or off. If the dialysis machine does not allow for turning off the dialysate flow, or if doing so violates clinic policy, decrease the dialysate flow to its minimum setting.
   ii. Decrease the blood flow to 100 mL/min for 15 s (longer if the bloodline volume to the sampling port exceeds 15 mL). To prevent pump shut-off as the blood flow rate is reduced, it may be necessary to manually adjust the venous pressure limits downward. At this point, proceed to obtain your samples. You can either shut off the blood pump before sampling, or leave it running at 100 mL/min while the sample is being drawn.
   iii. After the sample has been obtained, stop the blood pump (if not already stopped) and complete the patient disconnection procedure as per dialysis clinic protocol

TMP, transmembrane pressure; UFR, ultrafiltration rate. Adopted with permission from Reference [51].

completion of HD and resolves in less than 1 min, usually within 20 s. The second component of early urea rebound is caused by CAPR that begins approximately 20 s after stopping HD and is completed 2–3 min after slowing or stopping the blood pump.[55] CAPR refers to the routing of just-dialyzed blood through the veins to the heart, then the pulmonary circuit, and back to the access without the passage of the just-dialyzed blood through any urea-rich tissues.[55–58] The late phase of urea rebound (>3 min) is completed within 30–60 min after stopping dialysis. This late phase is a consequence of flow-volume disequilibrium[59] and/or delayed transcellular movement of urea.[57,60]

Decreasing blood flow to 100 mL/min avoids the entry of just-dialyzed blood into the access and stops AR. Waiting 15 s at this flow rate will ensure that the uncontaminated blood (with just-dialyzed blood) has passed through the all dead space between the starting point of the dialyzer arterial inlet blood tubing and the sampling port area. Therefore, the sampled blood should not be contaminated with the just-dialyzed blood originated from AR.[51] The Kt/V calculated from this post-dialysis urea sample is regarded as spKt/V. The procedures for obtaining post-dialysis blood sample using the slow-blood-flow method are shown in Table 1.

5.1.3 Minimally adequate HD dose

Guideline statements

5.1.3.1 The minimum delivered dose for patients dialyzing three times per week (excluding residue renal function) should be a spKt/V value of 1.2. (R)

5.1.3.2 The minimum delivered dose for patients dialyzing two times per week (excluding residue renal function) should be a spKt/V value of 1.8. (D)

5.1.3.3 For HD schedules more frequent than thrice weekly, for example, nocturnal home HD, the suggested method for measurement of delivered dose is standard Kt/V (stdKt/V). The minimum delivered dose should be a stdKt/V value of 2.0 per week. (R).

Background and rationale

Guideline 5.1.3.1

A mechanistic analysis of the National Cooperative Dialysis Study showed that Kt/V < 0.8 was associated with a relatively high rate of morbidity, whereas Kt/V values between 1.0 and 1.2 were associated with a low rate of morbidity.[34] Retrospective studies have suggested an improved survival with higher delivered doses of HD up to Kt/V 1.2.[61,62] A decision analysis was performed using these data and published in 1993.[63] Based on this analysis, the Renal Physicians Association of USA recommended that the delivered Kt/V should be at least 1.2. This recommendation was adopted by the National Kidney Foundation-K/DOQI Clinical Practice Guidelines for Hemodialysis Adequacy 1997 and 2000.[52,64] The primary results of the HEMO Study, published in 2002, which randomized patients to a delivered eKt/V of 1.16 (standard dose) *vs* 1.53 (higher dose), equivalent to spKt/V of 1.32 *vs* 1.71, respectively, revealed no benefit from a higher dialysis dose than that recommended by the K/DOQI guidelines 2000.[21] The lack of benefit appeared not only in the primary outcome of mortality, but also in the main secondary outcomes relating to various causes of hospitalization combined with mortality. Therefore, the recommendation remained unchanged in the update K/DOQI Clinical Practice Guidelines 2006 and 2015.[51,65]

Guideline 5.1.3.2

There is lack of studies on the survival of patients dialyzing HD two times per week. It is the Work Group's opinion that the minimum delivered dose for patients dialyzing two times per week (excluding residue renal function) should be an spKt/V of 1.8. Clinical parameters should also be assessed when interpreting the spKt/V value for dialysis adequacy.

Guideline 5.1.3.3

Standard Kt/Vurea (stdKt/V) is defined as a hypothetical continuous clearance in patients receiving intermittent HD that is based on pre-dialysis blood urea concentration. The clearance was based on achieving equivalent average pre-dialysis urea concentrations, regardless of how many dialysis sessions are given per week. stdKt/V is considered a 'continuous equivalent clearance' that allows comparison of continuous with intermittent dialysis and is based on the equivalence of outcomes in patients dialyzed with continuous ambulatory peritoneal dialysis and those dialyzed with thrice weekly HD.[66] It is calculated as G/(mean pre-dialysis urea) where G is urea generation rate. The calculation was based on a fixed volume model of urea kinetics during an entire week and is expressed as weekly stdKt/V. This method was first presented by Gotch[66] and was later simplified by Leypoldt[67]:

$$\text{stdKt/V} = \frac{10\,080\frac{1-e^{-\text{eKt/V}}}{t}}{\frac{1-e^{-\text{eKt/V}}}{\text{eKt/V}} + \frac{10\,080}{\text{Nt}} - 1}$$

where N is number of treatments per week and t is treatment time in minutes. Calculation of stdKt/V from this equation requires eKt/V which can be derived from the Tattersall equation[68]:

eKt/V = spKt/V $[t/(t + 30)]$

where t is treatment time in minutes.

For HD schedules more frequent than thrice weekly, for example, nocturnal home HD, the minimum delivered dose should be a stdKt/V of 2.0 per week. This is the level obtained when one dialyzes thrice weekly HD to a spKt/V of 1.2 per treatment over 3.5 h.[51]

Audit items

spKt/V frequency distribution
stdKt/V frequency distribution
Percentage of patients with spKt/V < 1.2 when dialyzing three times per week
Percentage of patients with spKt/V < 1.8 when dialyzing two times per week
Percentage of patients with stdKt/V < 2.0 when dialyzing more than three times per week

5.2 Correction of anaemia in HD patients

Guideline statements

5.2.1 A target haemoglobin level of 10–11.5 g/dL should be achieved in patients who have been stabilized on HD. (D)

5.2.2 A haemoglobin level of >13 g/dL should be avoided. (D)

5.2.3 Iron supplement should be given to keep a percent transferrin saturation value (TSAT, serum iron divided by total iron-binding capacity × 100) of 21%–30% and a serum ferritin level of 449–1124 pmol/L (or 200–500 μg/L). (D)

5.2.4 Haemoglobin monitoring should be done at least monthly. (D)

5.2.5 Serum ferritin and TSAT should be checked at least every 3 months during erythropoietin-stimulating agents (ESAs) therapy. (D)

Background and rationale

Anaemia of chronic kidney disease (CKD) is associated with an increased risk of cardiovascular morbidity and mortality. It could be corrected by ESAs, repeated blood transfusion and androgens. Iron supplementation is also important if the serum TSAT and ferritin levels are suboptimal.

Amongst the treatment options, the use of ESAs is preferred because these agents reduce need of blood transfusion and hence minimize the risk of transfusion-related complications, namely transfusion associated infection, sensitization before renal transplant and iron overload. Great caution has to be taken in using ESAs in CKD patients with history of stroke, thrombo-embolic events or malignancy because of higher recurrent risk of the first two medical conditions, and 12.3-fold greater risk of cancer-related death for patients with history of malignancy.[69,70]

Common causes of anaemia (e.g. iron deficiency, blood loss and haemolysis) have to be ruled out and corrected before considering ESAs. The target haemoglobin level of 11–12 g/dL is suggested by various guidelines.[70–72] It is not recommended to target the haemoglobin level >13 g/dL because of the higher risk of all-cause mortality and arteriovenous access thrombosis.[70–73] Use of iron supplement is not recommended if the TSAT level is >30% or the serum ferritin level >1124 pmol/L (or 500 μg/L).[70]

Audit items

Percentage of patients receiving ESAs
Haemoglobin frequency distribution
Percentage of patients with Hb <10 g/dL
TSAT and serum ferritin frequency distribution

5.3 Nutritional status in HD patients

Guideline statements

5.3.1 Regular assessment by dietician is desirable. (D)

5.3.2 The recommended serum albumin level is >35 g/L. (D)

5.3.3 The recommended normalized protein equivalent of total nitrogen appearance (nPNA) value is 1.0–1.4 g/kg ideal bodyweight/day. (D)

5.3.4 The recommended caloric intake is 30–35 kcal/kg ideal bodyweight/day depending upon age and physical activity. (D)

5.3.5 The pre-dialysis serum albumin or the nPNA value should be checked at least every 3 months. (R)

Background and rationale

Under-nutrition is common in the HD population and regular assessment of the nutritional status should be part of the routine care. There is no single best method and it is suggested to monitor multiple parameters to evaluate the nutritional status.

Low serum albumin is a powerful predictor of mortality in dialysis patients. It has been shown that the mortality risk was 1.38-fold higher for patients with serum albumin level <35 g/L.[74] Moreover, each 10 g/L fall in serum albumin level was associated with a 39% increase in risk of cardiovascular death.[75] Use of the serum albumin as a nutritional index, however, is limited by the fact that its level could be affected by other non-nutritional factors, for example, changes in the extracellular volume, inflammation and hypercatabolism.

In stable patients who are at a steady state, net protein catabolism is equal to protein intake. Because of this relationship, dietary protein intake can readily be gauged by determination of the net protein catabolic rate (also known as protein equivalent of total nitrogen appearance, PNA). The PNA value is usually normalized to the bodyweight (nPNA, g/kg bodyweight/day) to allow direct comparison between patients. The best survival was observed with nPNA values of 1.0–1.4 g/kg bodyweight/day, whereas increased mortality was associated with nPNA values <0.8 or >1.4 g/kg bodyweight/day.[76]

Since urea is a by-product of protein breakdown, nPNA can be assessed either by gauging the increment in plasma urea concentrations during the interdialytic period, or by using formulae based on pre-dialysis plasma urea and spKt/V values of the same dialysis session.[77–79] Some authorities may prefer the use of formal UKM in the estimation of nPNA but the drawback is that the model involves complex equations. Hence, the following two approaches are recommended.

Method I: nPNA by change of plasma urea levels in the interdialytic period:

$$nPNA = 0.22 + \frac{2.419 \times (C_2 - C_1)}{T} + R$$

where C_1 represents postdialysis plasma urea in mmol/L, C_2 represents next pre-dialysis plasma urea in mmol/L and T represents the interdialytic interval in hours. R is the total urea lost in urine. It will be deleted from the equation if the urine output is ≤100 mL/day. Among patients with significant residual renal function (urine output >100 mL/day), R is estimated from the following formula:

$$\frac{4.2 \times U}{T \times BW}$$

where U represents the urinary urea (in mmol) excreted in a urine collection obtained from the end of one dialysis to the beginning of the next dialysis, and BW represents bodyweight in kg.

Method II: nPNA by the predialysis plasma urea and spKt/V values of the same dialysis session.

$$nPNA = \frac{2.8 \times C_0}{A + (B \times spKt/V) + \frac{C}{spKt/V}} + 0.168$$

where C_0 represents the predialysis plasma urea in mmol/L and spKt/V represents the single-pool Kt/V.

A, B and C are constants and the values depend on the dialysis and blood taking schedules. For patients undergoing thrice-weekly dialysis treatments, and if the blood taking schedule is at the first dialysis of the week, A = 36.3, B = 5.48 and C = 53.5;

if the blood taking schedule is at the midweek dialysis, A = 25.8, B = 1.15 and C = 56.4;

if the blood taking schedule is at the final dialysis of the week, A = 16.3, B = 4.3 and C = 56.6.

For patients on a twice-weekly schedule, if the blood taking schedule is at the first dialysis of the week, A = 48, B = 5.14 and C = 79;

if the blood taking schedule is at the final dialysis of the week, A = 33, B = 3.6 and C = 83.2.

In patients with significant residual renal function (urine output >100 mL/day), C_0 should be replaced by C_0':

$$C_0' = C_0 \times \left(1 + \left(D + \frac{E}{spKt/V}\right) \times \frac{Kr}{V}\right)$$

where Kr represents residual renal urea clearance in mL/min and V represents the volume of urea distribution (also known as the total body water) in litres.

For patients undergoing thrice-weekly dialysis treatments, D = 0.70 and E = 3.08.

For patients on a twice-weekly schedule, D = 1.15 and E = 4.56.

V can be estimated by the Watson formulas[80]:

For male: V = 2.447 + (0.3362 × BW) + (10.74 × H) − (0.09516 × Age).

For female: V = − 2.097 + (0.2466 × BW) + (10.69 × H).

where BW represents bodyweight in kilograms, H represents body height in meters and age is in years.

Finally, it should be noted that the nPNA values estimated by these two methods are not normalized to ideal bodyweight. Such values may be misleading in malnourished or obese patients. Because of this, it is suggested to aim the nPNA values towards the higher end of the nPNA targeted range (e.g. 1.4 g/kg/day) for patients who are malnourished (e.g. with actual body mass index (BMI) values <20 kg/m^2). Similarly, it is suggested to set one's goal with the nPNA values towards the lower end of the nPNA targeted range (e.g. 1.0 g/kg/day) for patients who are obese (e.g. with actual BMI values >25 kg/m^2).

Audit items

Serum albumin and nPNA frequency distribution
Percentage of patients with serum albumin ≤35 g/dL
Percentage of patients with nPNA <1.0 g/kg/day

5.4 Blood pressure control in HD patients

Guideline statements

5.4.1 Interdialytic blood pressure (BP) monitoring (self-measured home BP or ambulatory BP monitoring) is preferred. (D)

5.4.2 The target self-measured home BP is <140/90 mmHg. (D)

Background and rationale

The optimal BP target in the HD population is less well studied. Recommendation of pre-dialysis BP <140/90 and post-

dialysis BP < 130/80 by previous guideline is extrapolated from studies in the non-HD population, and is largely opinion-based.[81] Evidence is accumulating that interdialytic BP monitoring may be more important in predicting outcomes. Interdialytic BP monitoring refers to self-measured home BP monitoring and ambulatory BP monitoring. Of these, self-measured home BP monitoring is recommended because ambulatory BP monitoring is practically difficult to implement though it is considered the gold standard in diagnosing hypertension. In contrast to pre- and post-dialysis BP, self-measured home BP correlates well with clinical outcomes.[82,83]

There is lack of prospective randomized trial to evaluate the self-measured home BP target for HD patients. Prospective non-randomized studies observed a positive linear relation between the self-measured home systolic BP and the mortality risk,[83] and the BP readings of 125–145 mmHg associated with the best all-cause mortality.[82] Recently some American academic societies recommend a BP of <140/90 mmHg for patients who are at high risk for coronary heart disease. It may be appropriate to extrapolate such a recommendation to the HD population whom is also considered high risk for coronary heart disease, and to maintain an interdialytic self-measured home BP of <140/90 mmHg.[84] If pre- and post-dialysis BP monitoring is preferred, it is suggested the goals be <140/90 and <130/80 mmHg, respectively.[81]

Finally, it should be emphasized that non-pharmacological approaches, such as dietary sodium restriction, optimal fluid removal with dialysis and avoidance of high dialysate sodium, are important in optimizing the BP control in HD patients.[85]

Audit items
Systolic and diastolic pressure frequency distribution.

5.5 Bone profiles in HD patients

Guideline statements
5.5.1 The serum level of corrected total calcium (adjusted for albumin concentration) should be maintained within the normal reference range. (D)

5.5.2 The target serum phosphate level is 1.2–1.8 mmol/L. (D)

5.5.3 The target serum intact plasma parathyroid hormone (iPTH) level is 2–9 times the upper normal limit. (D)

5.5.4 Predialysis serum calcium and phosphorus concentration should be measured at least every 3 months. (R)

5.5.5 Serum iPTH level should be measured at least annually. (R)

Background and rationale
Hypocalcaemia, diminished 1,25-dihydroxyvitamin D level and hyperphosphataemia are major factors for the development of secondary hyperparathyroidism in patients with CKD. Failure to control these abnormalities would lead to renal osteodystrophy and soft tissue calcification including vascular calcification. On the other hand over-suppression of parathyroid hormone may lead to adynamic bone disease and should be avoided.[86,87]

Audit items
Predialysis corrected total calcium, phosphorus, serum albumin, iPTH frequency distribution

6. VASCULAR ACCESS

6.1 Acute HD vascular access – non-cuffed catheters

Guideline statements
6.1.1 Non-cuffed HD catheters should only be intended for short-term use. (R)

6.1.2 Non-cuffed catheters are preferably inserted into the right jugular vein. Femoral catheters should be used for no more than 1 week. Placement of double lumen catheter in the subclavian vein should be avoided if at all possible. (D)

6.1.3 The tip of non-cuffed HD catheters should be in the superior vena cava for jugular placement and ideally in the inferior vena cava for femoral catheters to minimise recirculation. (D)

6.1.4 Acute HD catheter should only be inserted under aseptic technique. The central line insertion bundle should be followed. (R)

6.1.5 Insertion of catheter should be performed under real-time ultrasound guidance. (D)

6.1.6 Position of jugular/subclavian catheters should be confirmed radiologically. (R)

Background
An ideal acute HD vascular access allows timely initiation of HD, deliver adequate dialysis dose, and is safe and easy to insert. Non-cuffed catheters are commonly used for this purpose. However, its use is not without complications. Hence, it should be used with caution.

Rationale
Guideline 6.1.1
Use of acute non-cuffed catheters is associated with increased complication rate when compared with tunnelled-cuffed catheters (TCCs). The rate of bloodstream infection is notably high in acute catheters when compared with chronic cuffed catheters (2.6–6.5 per 1000 catheter days *versus* 0.8–2.7 per 1000 catheter days, respectively.[88,89] A non-cuffed catheter should be removed promptly if it is no longer needed.[90] It should be changed to a TCC if prolonged renal replacement therapy is expected.[88,91]

Guidelines 6.1.2 and 6.1.3
Placement of HD catheter into right internal jugular vein provides direct access to the superior vena cava. It runs a lower

risk of central vein stenosis and peri-procedural complications when compared with other catheter insertion sites.[92] Large bore HD catheter in the subclavian vein carries a high risk of central vein stenosis or occlusion which will affect subsequent construction of permanent vascular access on the ipsilateral upper limb, hence it should be avoided.[88] Placement of HD catheter in common femoral vein is associated with high rate of bacteraemia when compared with mediastinal catheters, its risk markedly increases after 1 week of catheter placement.[93] Left internal jugular vein catheter runs a more tortuous anatomical course, hence the risks of central vein stenosis and catheter malfunction are high.[88,89]

The tip of HD catheter should be placed in a large blood vessel to achieve maximal blood flow rate and to minimize recirculation.[88,94] The tip of jugular catheter should ideally be placed in the superior vena cava.[88,91,94] For femoral catheters, a high rate of recirculation is noted if the tip is located in the iliac vein. Therefore, femoral catheter should be placed in the inferior vena cava.[88,94]

Guideline 6.1.4
HD catheters should be inserted under aseptic technique to minimize catheter-related infection. The central line insertion bundle includes the following practices:

1. The operator should perform hand hygiene.
2. Maximal barrier precautions including cap, mask, sterile gown, gloves and a sterile full-body drape should be applied during catheter insertion.[90,94,95]
3. Skin preparation using 2% chlorhexidine before catheter insertion is preferred.[90] It has been shown that use of chlorhexidine solution is associated with less catheter-related bacteraemia when compared with povidone-iodine solution.[96]
4. Antiseptics should be allowed to dry before catheter placement.[90]

Guideline 6.1.5
There are considerable variations in anatomical relations between the central veins and their corresponding arteries at both jugular and femoral sites. Use of real-time ultrasound guidance during venous cannulation reduces procedure-related complications. It has been shown that the chance of arterial puncture, the number of puncture attempt and haematoma formation are reduced.[89,91,94,97] Therefore, real-time ultrasound guidance should be employed during HD catheter placement, even for femoral sites.[89] For operators who are not used to real-time ultrasound-guided cannulation techniques, a pre-procedural ultrasound should at least be performed to confirm the anatomy and patency of the selected blood vessel.[89]

Guideline 6.1.6
A chest radiograph should be taken post-catheter insertion to confirm catheter position for mediastinal catheters and to look for potential complications such as pneumothorax and haemothorax.[91]

6.2 Tunnelled-cuffed catheters

6.2.1 Placement of TCC

Guideline statements

6.2.1.1 TCC is preferably placed in the right internal jugular vein. Placement of TCC on ipsilateral side where an arteriovenous fistula (AVF) or arteriovenous graft (AVG) is being created or under maturation should be avoided. (R)

6.2.1.2 The tip of TCC should be placed in proximal right atrium. (D)

6.2.1.3 TCC catheter should always be inserted under real-time ultrasound guidance and its position should be confirmed radiologically. (R)

6.2.2 Prevention and treatment of catheter-related infections

Guideline statements

6.2.2.1 Catheter hubs and exit site should be cleansed with 2% chlorhexidine or other antiseptic according to manufacturer's suggestion. (R)

6.2.2.2 Application of mupirocin or povidone-iodine ointment (choice to be guided by manufacturer's suggestion) to catheter exit site may reduce catheter-related infection (D)

6.2.2.3 Catheter-related infections should be treated according to the severity and extend of infection (R)

6.2.3 Management of catheter dysfunction

Guideline statements

6.2.3.1 Catheter dysfunction should be identified and evaluated early to salvage catheter function. (R)

6.2.3.2 Catheter dysfunction due to thrombosis or fibrin sheath should be treated with thrombolytic therapy. (R)

Background

The cuff of TCC allows epithelialisation of catheter exit site which forms a barrier against infection. TCCs are occasionally used as a permanent vascular access in patients whom creation of arteriovenous accesses is not possible or not advisable. Every effort should be made to achieve adequate blood flow rate, minimize recirculation and facilitate delivery of adequate dialysis dose. It is also important to maintain catheter survival and minimize infection.

Rationale

Guideline 6.2.1.1
The right internal jugular vein runs a straight anatomical course into the right atrium through the superior vena cava. Placement of catheter into left internal jugular catheter has a high risk of venous stenosis and catheter malfunction since it runs a more tortuous anatomical course. Femoral catheters and translumbar catheters have a higher rate of infection.[91]

Placement of a TCC on ipsilateral side of an arteriovenous access may induce stenosis and jeopardise the vasculature condition for creation and maturation of permanent peripheral access in future.[91]

Guideline 6.2.1.2
TCC is typically made of soft material, for example, silicon or silastic elastomer. Soft material permits a larger lumen size and allows its tip to be placed in the right atrium. Hence, it can achieve a blood flow rate greater than 300 mL/min and recirculation can be minimized, which is important to deliver adequate dialysis dose.[94]

Guideline 6.2.1.3
Real-time ultrasound should be used, for the same reasons as stated in Section 6.1.5 'Acute HD vascular access – Non-cuffed catheters'. It minimizes peri-procedural complications and increases the chance of successful placement. The position of catheter tip should be confirmed by radiological images.[91,94]

Guideline 6.2.2.1
Catheter hub and exit site handling using 2% chlorhexidine is shown to be superior in reduction of catheter-related infections. Hence, use of 2% chlorhexidine for catheter care is recommended. Povidone-iodine can be used if chlorhexidine is incompatible with the catheter material.[91,98]

Guideline 6.2.2.2
Clinical trials have shown that application of topical mupirocin or povidone-iodine to catheter exit sites effectively reduces catheter-related bacteraemia.[91,98–100] Topical mupirocin prevents catheter-related bacteraemia by reducing Staphylococcal infections.[90]

Guideline 6.2.2.3
The scope of catheter-related infections ranges from exit site infection, to tunnel infection and catheter-related bacteraemia. In principle, a microbiological diagnosis should always be obtained if possible and the infection should be treated according to the organism identified. Catheter-related infections should be treated according to severity of infection.

Uncomplicated exit site infections can be treated by topical antibiotics. Systemic antibiotics should be given if there is evidence of purulence or systemic infection.[91,98,101] Catheter should be removed in case of tunnel tract infection and systemic antibiotic should be given for 7–10 days.[98,99,101]

In order to diagnose catheter-related bacteraemia, blood cultures should be obtained before initiation of antibiotics. Catheter-related bacteraemia is definite if (i) blood culture from catheter lumen yields the same organism 2 h earlier than that from peripheral blood; or (ii) a quantitative blood culture from catheter lumen has at least three times the number of colonies of the peripheral blood sample.[101]

Systemic antibiotic is necessary in the treatment of catheter-related bacteraemia. The following approaches have been described:

1. Attempt to salvage TCC by addition of high concentration antibiotic lock solution to the catheter lumen after every dialysis, provided symptoms of infection subside within 48 h of treatment.[91,101] This method has a 65%–70% success rate.[91] It is not recommended for infections due to Staphylococcal aureus, Pseudomonas and fungal species.[98,101]
2. Catheter removal and delayed insertion of a new dialysis catheter is required in cases with evidence of severe sepsis, tunnel tract infection, metastatic infection and fungal infection or in cases where an attempt to salvage the TCC has failed.[91,95,98,99] The Infectious Disease Society of America (IDSA) recommends catheter removal in cases of infections due to Staphylococcal aureus, Pseudomonas and fungal species.[101]

Guideline 6.2.3.1
Mechanical failure is a major cause of TCC removal.[102] A TCC is malfunction if it fails to deliver adequate blood flow for HD, defined as 300 mL/min in the K/DOQI guidelines.[91] Common causes of catheter malfunction include presence of intra-luminal or catheter tip thrombus, occlusion due to fibrin sheath and formation of mural thrombus.[94] Early thrombolytic therapy increases the chance of restoration of catheter patency.[91] Radiological examination with contrast should be performed to evaluate TCC malfunction if it does not respond to initial management.[91]

Guideline 6.2.3.2
Different protocols of thrombolytic administration with tissue plasminogen activator (tPA) and urokinase have been described in the literature. In general, thrombolytic can be administered as a dwell, a dwell with intermittent push, or continuous infusion.[103] There is no conclusive data on comparison of different agents and protocols.[91,103] Each dialysis unit should develop its thrombolytic protocol base on availability, cost and practical consideration for drug administration.[91]

Other means of treatment include (i) catheter replacement alone, (ii) catheter replacement plus disruption of fibrin sheath, and (iii) stripping of fibrin sheath from a femoral approach. These modalities are more invasive and may be considered in case thrombolytic therapy has failed.[91,103]

Audit item
Incidence of catheter-related bacteraemia in the dialysis unit

6.3 Permanent vascular access (primary arteriovenous fistula (AVF) and arteriovenous graft (AVG))

6.3.1 Patient preparation for permanent vascular access

Guideline statements
6.3.1.1 The upper limb veins suitable for creation of vascular access should not be used for venipuncture. (R)

6.3.1.2 Evaluation should be carried out before creation of a permanent vascular access. This includes physical examination and duplex ultrasound of upper limb arteries and veins. (D)

Background and rationale

Guideline 6.3.1.1

Venipuncture complications may render veins potentially available for vascular access unsuitable for creation of a primary fistula. Patients and health-care professionals should be educated about the need to preserve veins to avoid loss of potential access sites in the upper limbs for successful fistula creation.[91,92]

Guideline 6.3.1.2

Duplex ultrasound is the preferred method for preoperative vascular mapping which refers to the evaluation of both arteries and veins and is recommended to be performed in all patients before creation of vascular access.[91] Preoperative vascular mapping has been shown to substantially increase the total proportion of patients dialyzing with fistulae.[104–106] Most studies recommended a minimum arterial diameter of at least 1.6 mm[91] and studies have shown that 2.0–2.5 mm vein diameter is the threshold for successful creation of a fistula.[106,107]

6.3.2 Selection and placement of permanent vascular access

Guideline statements

6.3.2.1 Fistula First Catheter Last Policy is recommended. Radiocephalic fistula is the preferred vascular access, followed by brachiocephalic fistula, and lastly an arteriovenous synthetic graft. (R)

6.3.2.2 Long-term HD catheter should be avoided if possible. (R)

Background and rationale

The preference of fistulas over all other forms of access arises from their functional advantages of having a lower rate of complications. Fistulas have the lowest rate of thrombosis[108] and require the fewest interventions[108,109] providing longer survival of the access.[108–111] As a result, costs of implantation and access maintenance are the lowest.[111,112] Fistulas have lower rates of infection than grafts, which, in turn, are less prone to infection than percutaneous catheters.[113] Fistulas are associated with increased survival and lower hospitalization. Patients receiving catheters (RR = 2.3) and grafts (RR = 1.47) have a greater mortality risk than patients dialyzing with fistulas.[114] Epidemiological evidences also indicate that greater use of fistulas reduces mortality and morbidity.[114–116] In view of these advantages of AVF, the End Stage Renal Disease National Coordinating Center established the Fistula First Catheter Last Workgroup Coalition to focus on increasing the use of AVF and decreasing the use of tunnelled dialysis catheters in HD patients.[117]

Audit item

Percentage of patients using catheter for dialysis in the dialysis unit

6.3.3 Cannulation of fistulae and grafts

Guideline statements

6.3.3.1 An AVF should be mature before cannulation and able to deliver the prescribed blood flow during the HD treatment. AVF should not be cannulated until 4 weeks after creation. (D).

6.3.3.2 An AVG should not be cannulated until 2 weeks after placement. (R)

6.3.3.3 If a fistula fails to mature by 6 weeks, a fistulogram or other imaging study should be performed to investigate the cause. (R)

Background and rationale

Patients should have a functional and mature permanent access before cannulation. Function implies that the access not only delivers adequate blood flow for dialysis, but also can be cannulated easily. In general, such an access has a flow rate greater than 600 mL/min, diameter at least 0.6 cm, and no more than 0.6 cm deep (rule of 6 s).[91] An AVF should not be cannulated until 4 weeks after creation[118] since premature cannulation of a fistula may result in a greater incidence of infiltration, with associated compression of the vessel by haematoma and permanent loss of the fistula. An AVG should not be cannulated until 2 weeks after placement and until swelling has subsided to allow palpation of the course of the graft.[91] If a fistula fails to mature by 6 weeks, a fistulogram or other imaging study should be performed to investigate the cause.[91]

6.4 Monitoring and surveillance of permanent vascular access for access dysfunction (primary AVF and AVG)

Guideline statements

6.4.1 Fistulae and grafts should be regularly monitored for stenoses. The surveillance methods that can be used are intra-access flow measurement, static venous pressure, duplex ultrasound and physical examination of arm swelling, altered characteristic of thrill in the outflow vein or graft, or prolonged haemostasis after needle withdrawal. (D)

6.4.2 Patient should be referred for evaluation and treatment of when persistent abnormalities are detected in any of the monitoring parameters, an access flow rate <600 mL/min in grafts and <400–500 mL/min in fistulae, and when a venous segment static pressure ratio >0.5 in grafts or fistulae or an arterial segment static pressure ratio >0.75 in graft. (D)

Background and rationale

Vascular access function and patency are essential for HD treatments. Loss of patency limits HD delivery, extend treatment times and results in underdialysis that leads to

Table 2 Static intra-access pressure (IAP) surveillance

a. Establish a baseline when the access has matured and shortly after the access is first used. Trend analysis is more useful than any single measurement.
b. Assure that the zero setting on the pressure transducers of the dialysis delivery system being used has been calibrated to be accurate within ±5 mmHg.
c. Measure the mean arterial blood pressure (MAP) in the arm contralateral to the access.
d. Enter the appropriate output or display screen where venous and arterial pressures can be visualized (this varies for each dialysis delivery system). If a gauge is used to display pressures, the pressure can be read from the gauge.
e. Stop the blood pump and cross clamp the venous line just proximal to the venous drip chamber with a haemostat (this avoids having to stop ultrafiltration for the brief period needed for the measurement). On the arterial line, no haemostat is needed since the occlusive roller pump serves as a clamp.
f. Wait 30 s until the venous pressure is stable, then record the arterial and venous IAP values. The arterial segment pressure can only be obtained if a pre-pump drip chamber is available and the dialysis system is capable of measuring absolute pressures greater than 40 mmHg.
g. Unclamp the venous return line and restore the blood pump to its previous value.
h. Determine the height correction, Δh between the access and the drip chamber(s) either by direct measurement (A) or using a formula (B) based on the difference in height between the top of the drip chamber and the top of the arm rest of the dialysis chair (Δ). Both measurements need to be in cm. Height corrections are not needed if the measurements in step 6 are done with access level with the drip chamber.
    - Measure the height from the venous or arterial needle to the top of the blood in the venous drip chamber. The offset in Hg = height (cm) × 0.76.
    - Use the formula, offset in mm Hg = 3.6 + 0.35 × Δ.
i. The same correction values can be used for both if the two drip chambers are at the same height. If the drip chambers are not at equal heights, the arterial and venous height offsets must be determined individually. In a given patient with a given access, the height offsets need to be measured only once and then used until the access location is altered by construction of a new access.
j. Calculate the normalized arterial and venous segment static IAP ratio(s),
Arterial ratio = (arterial IAP + arterial height correction)/MAP
Venous ratio = (venous IAP + venous height correction)/MAP

Adopted with permission from Reference [91].

increased morbidity and mortality.[35] The aim of vascular access monitoring and surveillance is that stenoses develop over variable intervals in the great majority of vascular accesses and, if detected and corrected, underdialysis can be minimized or avoided and the rate of thrombosis can be reduced.[91]

Intra-access blood flow can be measured using methods including ultrasound dilution (Transonics) and duplex Doppler ultrasound.[91] Access flow rate <600 mL/min in grafts[119] and <400–500 mL/min in fistulae[120] are suspicious for the presence of haemodynamically significant stenosis. (These are overseas' references which may not represent that of local Chinese patients.) A recent randomized-controlled trial showed that intra-access blood flow-based surveillance combining Doppler ultrasound and ultrasound dilution reduces the frequency of thrombosis, and improves thrombosis free and secondary patency in AVF.[121]

For static venous pressure, the intra-access pressure (IAP) is measured using a manometer connected to the dialysis needle prior to turning on the dialysis pump (Table 2).[91,122] A venous segment static pressure ratio >0.5 in grafts or fistulae or an arterial segment static pressure ratio >0.75 in graft is suspicious for significant stenosis. Static venous pressures have a lower positive predictive value for stenosis in fistulas as compared with grafts.[122] The procedures for obtaining the static IAP are shown in Table 2.

Duplex ultrasound is probably the most reproducible and accurate AVG surveillance method. It measures the peak systolic velocity (PSV) on either side of a stenosis.[123] There are only limited data on the use of duplex ultrasound in fistula. Most of the studies have primarily evaluated AVG, but data also suggest duplex ultrasound may be useful for AVF.[123]

For AVG, a number of studies have observed that a haemodynamically significant stenosis is present in ~70%–90% of patients identified to have abnormalities on clinical monitoring.[124–126] Clinical monitoring refers to assessments that can be performed by physical examination of the access or by readily available information that is collected in the course of treating HD patients.[127] In general, clinical monitoring, most commonly by dialysis nurses, is less accurate for AVF compared with AVG to detect stenosis, although the evidence is conflicting. In one study, the positive predictive value of abnormalities of clinical monitoring detected by dialysis nurses, for >50% stenosis was only 39% for fistulas, compared with 69% for grafts.[125]

6.5 Management of permanent vascular access stenosis

Guideline statements

6.5.1 A fistula or graft with a greater than 50% stenosis in either the venous outflow or arterial inflow, which is haemodynamically significant, should be treated with percutaneous angioplasty. (R)

6.5.2 If angioplasty of the same lesion is required more than two times within a 3-month period, the patient should be referred for surgical assessment. (R)

Background and rationale

Abnormalities indicating haemodynamic significant stenosis include reduction in blood flow, increase in static pressures, or abnormal physical findings.[91] Recently, use of an absolute minimum luminal diameter in determining dysfunctional AVF has also been described since the percentage narrowing compared with the adjacent 'normal' vessel is sometimes inaccurate in AVF.[128] Underlying stenosis of vascular access is an important predictor of fistula or graft thrombosis.

Around 90% of thrombosed grafts have an underlying stenosis.[129,130] Therefore, angioplasty of a stenotic lesion has been advocated as the treatment of choice to prevent fistula or graft thrombosis and vascular access failure. Individual patients may have a rapid recurrence of stenosis that requires repeated angioplasty.[131,132] The K/DOQI Vascular Access Work Groups in 2000 have defined rapid recurrence of stenosis as the need for more than two angioplasty within a 3-month interval. In these patients, repeated angioplasty may not be cost-effective, and surgical revision may be beneficial.[133]

7. ANTICOAGULATION FOR HD

Guideline statements

7.1 Each dialysis unit should have a protocol to assess bleeding risk of the HD patients. (D)

7.2 Unfractionated heparin or low molecular weight heparin (LMWH) should be the anticoagulant of choice for patients without increased bleeding risk and contraindication for heparin. (R)

7.3 Saline flushing method or regional citrate anticoagulation should be the preferred method for patients with increased bleeding risk. (R)

7.4 Heparin-free HD should be the method for patients with contraindication for heparin. (R)

Background and rationale

Anticoagulation is essential during HD to prevent clotting of the extracorporeal circuit. Both over- and under-anticoagulation are undesirable. Each dialysis unit should have a protocol to assess the bleeding risk of the patients and to guide the anticoagulation method for the HD treatment. An example is the protocol proposed by Swartz and Port.[134]

For patients with low bleeding risk and in the absence of contraindication for heparin, unfractionated heparin or LMWH could be used to prevent clotting of the extracorporeal circuit.[135–137] The use of LMWHs might be preferred because of similar efficacy, easy handling, improved lipid profile and less hyperkalaemia though it is more expensive.[135]

For patients with high risk of bleeding, systemic anticoagulation should be avoided. If saline flushing method is chosen, strategies including the use of heparinized saline for priming of the circuit, heparin-coated dialyzer, bloodline design that lack a blood-air interface, a citrate-enriched dialysis fluid and a higher blood flow rate, as well as avoiding blood transfusion via inlet of the circuit, have been reported to reduce risk of clotting of the dialysis circuit.

For patients with contraindication for heparin (e.g. history of heparin allergy or type II heparin induced thrombocytopenia), any heparin exposure, including the potential hidden source of heparin in the circuit-priming solution (i.e. heparinized saline), dialysis membranes (i.e. heparin-coated dialyzer) and the catheter locking solution (for patients in whom central venous catheter was used for the dialysis treatment), should be avoided.

8. HOME HD

Guideline statements

8.1 Potential patients and their care partners should be formally assessed by the home HD team before recruitment into the program. (R)

8.2 The home HD training program should be conducted in a renal unit with home HD service, qualified nephrologists and renal nurses. (R)

8.3 AV fistula is preferred. (D)

8.4 Rope-ladder cannulation is preferred to buttonhole cannulation method to minimize the risk of access infection. (D)

8.5 If buttonhole cannulation technique is used, the use of topical antimicrobial prophylaxis over the cannulation sites is suggested. (D)

8.6 Buttonhole cannulation method is not recommended for AV graft. (R)

8.7 Anticoagulation with continuous infusion of unfractionated heparin is preferred. (D)

8.8 For intensive dialysis regimens, a dialysate calcium level of 1.5 mmol/L is suggested to maintain a neutral calcium balance. (D)

8.9 The pre-dialysis serum bicarbonate and phosphous levels need to be monitored regularly for any adjustment in dialysate bicarbonate level and phosphate-binding medications. (D)

8.10 Minimum adequate HD is a stdKt/V value of 2.0 per week. (R)

8.11 Quality of RO water and dialysis fluid for home dialysis should be the same as it is for in-centre HD. (R)

8.12 Measurements of the inorganic contaminants of the RO water should be done at least annually by accredited laboratories. (R)

8.13 Monitoring of the microbiological quality of the RO water should be done at least every 3 months. (R)

8.14 Monitoring of the microbiological quality of the dialysis fluid should be done at least every 3 months. (R)

Background and rationale

Despite the lack of prospective randomized clinical trials and the query of patient selection basis, home HD is considered the best dialysis modality by some investigators because of

the favourable clinical outcomes in uncontrolled studies. The superior outcomes are likely related to the home setting that allows longer and/or more frequent dialysis. It is equally important to inform patients about the potential risks including increased vascular access complications (namely, frequent interventions and access-related infection), increased burden for care partner, and a higher rate of decline in residual renal function.[85]

The buttonhole (or constant-site) technique for AV fistula cannulation has been the routine self-cannulation method for home HD patients because of less painful and faster in needle placement. Recently, the buttonhole technique is found to have higher risk of local and systemic infection than that of rope-ladder (or rotating sites) method.[138] The rope-ladder technique is now the preferred method for home HD patients. If buttonhole technique is chosen, prophylactic use of the mupirocin cream over the cannulation sites is preferred to reduce *Staphylococcus aureus* bacteremia.[139] There is no published data on use of buttonhole technique in AV graft and hence, is not recommended.

The recommendation of use of unfractionated heparin in home HD is based on studies from that of conventional HD. A loading dose followed by a continuous infusion throughout the HD treatment is preferred as repeated intermittent dosing is usually not practical, particularly for nocturnal dialysis. Study on use of continuous infusion of LMWH in home HD has also been published.[140]

Mass balance studies in patients having long-hour dialysis found that the use of a dialysate calcium level of 1.25 mmol/L associates with a fall in pre-dialysis calcium level as well as increases in alkaline phosphatase and intact parathyroid hormone levels. Such abnormalities could be reversed by increasing the dialysate calcium level and hence, a dialysate calcium level of 1.5 mmol/L is suggested. Intensive dialysis also leads to more phosphate removal and bicarbonate gain from the dialysis fluid. Regular monitoring of these parameters is needed to adjust composition of the dialysis fluid.[141,142]

The role of Kt/V value in predicting patient outcome is less well studied for patients on intensive dialysis. The Kt/V target is extrapolated from guidelines for patients on conventional HD. The use of weekly stdKt/V is preferred for more frequent and longer HD to allow direct comparison with other dialysis modalities.[143]

Quality of RO water and dialysis fluid for home dialysis should be the same as it is for in-centre HD. Frequency of monitoring is modified from international guidelines.[6,7,14,17,18,144]

Audit items

RO water

Inorganic contaminants, microbiological quality, test frequency and results

Dialysis fluid quality

Microbiological quality, test frequency and results

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APPENDIX

Table A1 Concentrations of inorganic compounds or elements in local drinking water and ANSI/AAMI/ISO water quality standards

	Average concentrations in drinking water (mg/L or ppm)	ANSI/AAMI/ISO upper limit in dialysis water (mg/L or ppm)
Aluminum	Not done	0.01
Antimony	<0.001	0.006
Arsenic	<0.001	0.005
Barium	0.013	0.1
Beryllium	Not done	0.0004
Cadmium	<0.001	0.001
Calcium	Not done	2
Chlorine (total)*#	0.7	0.1
Chromium	<0.001	0.014
Copper	<0.003	0.1
Fluoride*	0.48	0.2
Lead	<0.001	0.005
Magnesium	Not done	4
Mercury	<0.00005	0.0002
Nitrate*	4.5	2
Potassium	Not done	8
Selenium	<0.003	0.09
Silver	Not done	0.005
Sodium	Not done	70
Sulfate	Not done	100
Thallium	Not done	0.002
Zinc	Not done	0.1

Data from Water Supplies Department, Hong Kong (average figure in 10/2016–09/2017) and ANSI/AAMI/ISO: Water for haemodialysis and related therapies 13959:2014.[3,17,18] *Concentrations in drinking water higher than those recommended by ANSI/AAMI/ISO. #Total chlorine is the sum of free and combined chlorine, and chloramine is the principal component of combined chlorine.

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Supplement Article

Clinical practice guidelines for the provision of renal service in Hong Kong: Potential Kidney Transplant Recipient Wait-listing and Evaluation, Deceased Kidney Donor Evaluation, and Kidney Transplant Postoperative Care

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INTRODUCTION

The allocation of deceased organ follows the Hospital Authority Central Renal Committee Operation Policy on Deceased Donor Kidney Donation, Allocation and Transplantation.[1]

There are specific challenges for the wait-listing patients for renal transplant. Several major organizations have provided guidelines on the issue of kidney transplant patient assessment[2–6] while we acknowledge the small but important divergence of opinion among different guideline recommendations. A recent appraisal of guidelines on wait-listing for kidney transplant reported substantial variability in eligibility criteria, including recipient age cutoffs, estimated life expectancy, glomerular filtration rate (GFR) at listing, recommended cancer-free period.[7]

This chapter addresses the access to transplant with wait-listing and the evaluation, selection and preparation of the potential kidney transplant recipients.

1. ACCESS TO RENAL TRANSPLANTATION

Guideline statements

1.1. We recommend that kidney transplantation should be the renal replacement therapy of choice for patients with stage 5 chronic kidney disease who are considered fit for major surgery and for chronic immunosuppression [R]. All patients predicted to have an improved life expectancy post-transplantation should be assessed. Placement on the transplant waiting list will be limited by individual co-morbidity and prognosis.

1.2. We recommend considering pre-emptive and living donor transplantation for all patients suitable for renal transplantation if possible [R].

1.3. We recommend that patients suitable for transplantation be placed on the deceased kidneys transplant waiting list on starting dialysis after assessment [R], taking into account the local organ allocation system.

1.4. We recommend that age is not a contraindication to transplantation but age-related comorbidity or frailty should be evaluated [R].

Background

Access to transplantation wait list should be considered for suitable patients based on its treatment benefit in terms of quality of life and survival. Survival following renal transplantation is better compared to age-matched individuals remaining on the transplant waiting list.[8]

A legitimate concern for determining eligibility of older patients for kidney transplant wait-listing is raised in view of the aging population in Hong Kong.

Rationale

Guideline 1.1

Better patient survival following renal transplantation has been demonstrated in a landmark series of 46 164 patients on the transplant waiting list in the United States between 1991 and 1997; mortality was 68% lower for transplant recipients than for those remaining on the transplant waiting list for more than 3 years follow up.[8] Similar findings were replicated in the United Kingdom.[9]

Guidelines 1.2 and 1.3

The demand for renal transplantation has consistently and increasingly outstripped the number of available deceased donor organs. The deceased kidney waiting list is long and there are over 2000 patients on waitlist as of December 2016 in Hong Kong.

Living donor kidney transplantation provides most patients with the best chance of rehabilitation. The opportunity for

planned transplantation before dialysis should be actively explored because of reported improved patient and graft survival in pre-emptive transplantation.[10–12] Transplant survival is negatively influenced by the duration of dialysis before transplantation, as illustrated by a 5-year graft survival of approximately 85% in pre-emptive transplantation compared with 75% in those receiving dialysis for 3–4 years before transplantation in the United States.[13] On the other hand, such benefit was not shown for patients who are receiving a second transplant.

As stated in the position statement from the European Renal Best Practice (ERBP) Advisory Board, pre-emptive kidney transplantation should be planned in order to avoid dialysis, and is not based on a fixed, predetermined level of GFR.[14] Furthermore, superior graft survival of pre-emptive transplantation when compared with pre-transplant dialysis might be less pronounced in transplants performed since 2000, according to a recent analysis in the United States.[15]

Living kidney donation also enables scheduling of transplantation at a time when the recipient is in optimal medical and psychological condition, and may be the only option in high-risk recipients. The choice of living kidney donation should be made known to the patients and relatives.

Guideline 1.4

As mentioned in an analysis of published clinical practice guidelines, there is considerable controversy about cut-off for recipient age,[7] with six guidelines recommending patients should not be considered ineligible based on age. We understand that critical shortage of donor organs for kidney transplantation creates tension between maximizing utility and maintaining equity.

Proposed reasons for using age cut-off for transplant eligibility include higher surgical complications, infection and cardiovascular risk, and lack of data to support improved outcomes especially for patients in their late 70s and early 80s.[16] Despite an improved life expectancy and quality-adjusted life expectancy with transplantation in all age groups, cost-effectiveness analysis in the elderly[17] showed that receiving a deceased-donor transplant after a 2-year wait was not economically attractive for those who are older than 75. In fact, from an economic perspective, it has been suggested that living-donor transplantation is the preferred treatment option for older transplant candidates.[17]

On the other hand, it should be emphasized that improved life expectancy of first deceased donor transplant recipients over patients remaining on the waiting list is seen across all age groups. The subgroup analysis confirmed significant reduction in the relative risk of death after transplantation in all age groups, despite the greatest benefit achieved in patients aged 50–59 years.[9] The European Renal Association-European Dialysis and Transplant Association Descartes Working Group agrees that renal transplantation is safe in the elderly if candidates are carefully selected.[18] Although we agree that age per se is not a contraindication to transplant candidacy, elderly patients should be evaluated carefully for cardiovascular and malignant disease, as well as frailty. In general, the elderly patients should be encouraged to consider extended criteria donors and living donors to increase the access to renal transplantation.[18,19]

2. EVALUATION, SELECTION AND PREPARATION OF THE POTENTIAL TRANSPLANT RECIPIENT

Guideline statements

2.1. We recommend screening tests only in high-risk patients to identify those who need exclusion from the transplant waiting list [D]. There is no proven benefit of pre-transplantation screening for coronary artery disease in asymptomatic patients in preventing future cardiac events or reducing mortality after transplantation.

2.2. We recommend that elderly patients should not be excluded from the transplantation but to be vigorously evaluated and carefully selected before putting on the waiting list and prior to transplantation [D].

2.3. We recommend that patients should be strongly encouraged to stop smoking before and after transplantation [R]. Formal smoking cessation programmes should be offered and accessed in primary care.

2.4. We suggest caution with obese patients (body mass index (BMI) > 30 kg/m^2) based on the technical difficulties and increased risk of peri-operative complications. They should be screened rigorously for cardiovascular disease and considered on an individual basis [D]. Although obesity is not an absolute contraindication to transplantation, individuals with a BMI greater than 40 kg/m^2 would encounter higher complications.

2.5. We recommend that all transplant recipients should be tested for prior exposure to viral infections including cytomegalovirus (CMV), Epstein–Barr virus (EBV), hepatitis B and C and human immunodeficiency virus (HIV) [R].

2.6. We recommend offering hepatitis B vaccine to all uninfected transplant candidates with negative anti-hepatitis surface antigen (anti-HBs) status [R]. We recommend detailed evaluation of `-infected patients, including hepatitis B e antigen (HBeAg), serum hepatitis B virus (HBV) DNA and cirrhosis status, before wait-listing for kidney transplantation [D]. We recommend hepatologist consultation to decide for hepatitis C virus (HCV) treatment of renal transplant candidates [D].

2.7. We recommend screening for malignancy pre-transplant in accordance with the usual age-appropriate cancer screening policies for the general population [D]. We

recommend an appropriate disease-free interval before transplantation in patients with a previous malignancy [R].
2.8. We recommend waiting for the primary disease to become quiescent before transplant for those diseases that can recur and increase the risk of graft failure [D].

Background

The primary objective of pre-transplant assessment is to ensure the following items: transplantation is technically possible, the recipient's chances of survival are not compromised by transplantation, the graft survival is not limited by premature death (maximum benefit obtained from a limited resource), pre-existing conditions are not exacerbated by transplantation. Furthermore, it aims to identify measures to be taken to minimize peri- and post-operative complications and to inform patients of the likely risks and benefits of transplantation.

Rationale

Guideline 2.1

Despite a higher cardiovascular risk in patients with chronic kidney disease, it remains uncertain whether screening asymptomatic patients before kidney transplantation provides any benefit.[20] The optimal method of screening is also controversial.

Screening for cardiac or coronary disease before decisions to wait-list asymptomatic patients for kidney transplantation is based on expert opinion in the setting of observational data, which itself has mixed results. Most recommendations are rated to have weakest strength and the lowest level of evidence ratings.[20] An inconsistent practice pattern is highlighted by a comparison of four different screening guidelines of cardiac evaluation of renal transplant candidates, when applied to the same patient population, the range of proportion screened would be between 20% and 100%.[21]

A large retrospective single-centre study[22] reported the outcomes of 514 consecutive candidates for deceased-donor kidney transplantation who underwent an evaluation for possible coronary heart disease. Among low-risk patients (43.6%) who were not screened, the incidence of a cardiovascular event after being placed on the waitlist was extremely low (0.5%, 3.5% and 5.3% at 1, 3 and 5 years, respectively), although around 10% required intervention at a later stage.[22]

The American College of Cardiology (ACC)/American Heart Association (AHA) guidelines for preoperative non-invasive stress testing in kidney transplant candidates recommend risk stratification based on the presence of three or more coronary artery disease risk factors (regardless of functional status): diabetes mellitus, prior cardiovascular disease, dialysis for more than 1 year, left ventricular hypertrophy, age greater than 60 years, smoking, hypertension and dyslipidaemia.[23] In other words, the ACC/AHA recommendations differ from that of American Society of Transplantation (AST)[5] (which advises routine cardiac screening with non-invasive cardiac imaging in patients with diabetes mellitus on the basis of concerns for "silent" ischaemia). One of the reasons for arguing against routine screening diabetic transplant candidates derives from the prospective DIAD study,[24] in which 1123 asymptomatic patients with type 2 diabetes mellitus 50–75 years of age were randomized to adenosine technetium-99 m sestamibi-myocardial perfusion scintigraphy (MPS) or medical follow up. Coronary revascularization within 120 days of randomization occurred in 1.6% of the screened group and 0.4% of the medical follow-up group. There was no difference in the frequency of the primary endpoint, defined as cardiac death or nonfatal myocardial infarction over 5 years. These analyses have generated the call for optimal medical management, based on the premise that 'test no one and treat everyone' is more cost-effective than 'screen everyone with a test and treat only those with an abnormal test'.

Additional concerns exist about the tool of screening. We do not recommend specific choice, which often include dobutamine stress echocardiogram and MPS,[5–7] because previous Cochrane review reported only moderate sensitivity and specificity of these tools among kidney transplant candidates.[25] Other promising tool includes coronary artery calcium (CAC) score. In a prospective study of pre-transplant evaluation,[26] all 138 patients underwent MPS, coronary computed tomography angiography (CCTA), CAC and invasive coronary angiography. The sensitivity to detect obstructive coronary artery disease with structural imaging outperformed functional evaluation (93% CCTA *vs* 53% MPS). Using a threshold of 400 Agatston units, CAC had a reasonable (67%) sensitivity (67%) and specificity (77%) to predict obstructive coronary artery disease.[26]

Guideline 2.2

Management of elderly patients is often complex but specific evidence-based treatment guidelines are often lacking.

Virtually, all guidelines recommend careful selection of elderly for renal transplantation wait-listing, but the selection criteria are not clearly delineated.[8] Suggested considerations include minimum life expectancy (ranging from 2 to 5 years), reasonable probability of surviving beyond current waiting times for transplantation,[7] cardiovascular disease, malignancy,[5,6] more frequent re-evaluation (because of more rapid change in medical condition)[6] and functional status.

Although elderly patients with low physical function score appear to live longer after transplantation *versus* dialysis,[27] frailty or modified Charlson Comorbidity Index is an independent predictor of mortality in renal transplant recipients.[28,29] Several comorbidity scores and assessment of frailty can predict post renal transplant mortality and might

be used to guide decision-making on eligibility. The phenotypic frailty scale based on questions, and a modified one with measurements, designed by Fried[30,31] are often used. However, the level of such scores (as threshold to exclude patients from waiting list) should be defined and validated in additional studies.[18]

For cardiac evaluation, as stated above and by ACC/AHA,[23] non-invasive stress testing may be considered in asymptomatic patients 60 years or older who have at least two other risk factors for coronary artery disease, although there is little evidence to support this recommendation.

Cancer screening, a relevant issue in elderly patients, will be discussed in Guideline 2.6.

Guideline 2.3

For lifestyle factors, smoking cessation is strongly recommended by most guidelines[3,5,16] although few studies have examined the effect of cigarette smoking on renal transplantation. The most stringent guidelines specified a minimum smoking cessation period of 6 months before wait-listing for kidney transplantation.[6,32]

Concerns about smoking in kidney transplantation include vasoconstriction effect, increased malignancy, major cardiovascular events, reduced patient and graft survival.[33–35]

In the absence of evidence from randomized controlled study, one of the largest data set from the Collaborative Transplant Study included 46 548 first kidney transplant recipients (31 462 never smoked, 10 291 stopped smoking before transplantation, 4795 continued to smoke after transplantation). Patients who stopped smoking before transplantation had only a modestly increased risk of graft failure or death. Nonetheless, post-transplant smoking conferred a markedly increased risk of graft loss, all-cause death, cardiovascular and malignancy death.[35] The benefits from smoking cessation before kidney transplantation are clear despite the limitation of retrospective study design.

Guideline 2.4

There is diverse practice in wait-listing obese patients for renal transplant[8] although obesity is in general not a contraindication. Some guidelines stated that patients with a BMI greater than 40 kg/m^2 were 'unlikely to benefit' from kidney transplantation and required individual assessment.[2,3,16]

The impact of obesity on outcome after renal transplantation has been controversial and should be compared with outcomes on dialysis. United States Renal Data System (USRDS) registry data[36] have previously demonstrated a survival advantage for obese recipients of both deceased and living donor transplantation compared with remaining on dialysis. However, it should be noted that the benefit of renal transplantation did not apply to all and disappeared for patients with BMI greater than 41 kg/m^2.[36]

To assess the transplant risk, a systematic review and meta-analysis published in 2014 included 21 studies, with 9296 patients, and confirmed that obesity was associated with delayed graft function (relative risk 1.41), but not with acute rejection.[37] In addition, there was no association demonstrated between obesity and either graft loss or death in studies of recipients who received a transplanted kidney after 2000.[37] Another analysis of 191 091 patients, from the Scientific Registry of Transplant Recipient database between the period 1987 to 2013,[38] confirmed recipient obesity as independent risk factor for adverse outcomes, including delayed graft function, graft failure, proteinuria and acute rejection. In addition, a progressive increase in risk was linked with higher BMI categories. Another key observation was an increased risk even in pre-obese overweight recipients with BMI 25–29.9 kg/m^2 compared to normal weight.[38]

Guidelines 2.5 and 2.6

Pre-transplant screening of transplant candidates for their exposure to certain viruses, notably EBV and CMV, identified the at-risk patients. Antibody to the virus can be checked at the time or prior to renal transplant.

Although there are no large, randomized, controlled trials establishing the benefits of antiviral prophylaxis for EBV in transplant recipients, EBV-negative recipients of EBV seropositive kidney donors have a 7-fold increased risk of post-transplant lymphoproliferative disorder (PTLD).[39] Knowledge of recipient CMV serology at transplantation is also essential to guide antiviral prophylactic strategies.[40]

Potential transplant recipients who are not having immunity to hepatitis B virus should be offered hepatitis B vaccination, ideally before starting dialysis to improve the probability of seroconversion.[5,41] A serological response, as assessed by measuring anti-HBs 1 month after the last vaccine dose, should be confirmed.

Patients with HBV infection pose more challenge owing to their vulnerability to viral liver disease progression after use of immunosuppression. Consideration of HBV infection as a relative contraindication to kidney transplant is based on the observation of higher frequency of persistent viral replication and reactivation, liver histologic deterioration, cirrhosis and liver-related mortality.[42] This explains the recommendation to test for HBeAg and HBV DNA; patients with positive HBeAg or high circulating HBV DNA levels prior to transplantation are at high risk of reactivation or disease progression.[43]

The landscape of HBV patients' eligibility for renal transplant is changing after more widespread use of safe and effective antiviral therapy. This explains our inclination to make less concrete rules for allowing and excluding patients for renal transplant consideration. Individual decisions are also recommended by AST.[5]

Use of liver biopsy as part of the pre-transplant evaluation of HBV patients is recommended by some guidelines[5,16] to determine the presence of cirrhosis, although there is no strong supporting evidence. One of the implications from liver biopsy is to look for advanced liver cirrhosis, thus mandating referral for combined liver-kidney transplantation. Compensated liver cirrhosis secondary to HBV, on the other hand, is not necessarily a contraindication to kidney transplantation alone, in the current era of pre-emptive or prophylactic antiviral therapy. A recent single-centre Korean study[44] reported good outcome of kidney transplantation alone in 12 patients (8 with Child-Pugh class A and 4 with class B) between 1997 and 2011. Liver function worsened in only one of these patients and hepatocellular carcinoma was diagnosed in four patients after a median period of 35 months. Five-year patient survival was 100%.[44] However, kidney transplantation alone should not be recommended for HBV patients with decompensated cirrhosis, or those with compensated cirrhosis and portal hypertension.

In agreement with the Kidney Disease: Improving Global Outcomes (KDIGO) guidelines, we recommend screening all kidney transplant candidates for HCV infection.[45] Anti-HCV antibody testing is used to rule out HCV infection in low-prevalence areas whereas HCV RNA test is needed in high-prevalence areas. Similar to HBV scenario, liver biopsy is in general recommended to assess degree of liver damage before decision on kidney transplantation alone *versus* combined liver-kidney transplantation.[5] It is unclear whether non-invasive markers such as elastography can replace liver biopsy evaluation of HCV, partly because of the high sustained virological response rate of direct-acting antiviral drugs (DAA).[44] Because of the rapidly emerging data on DAA targeting viral proteins, we recommend collaboration with hepatologists for joint-decision. Timing of antiviral treatment – before *versus* after transplantation – depends on many factors, including HCV genotypes, degree of liver fibrosis, expected waiting time of transplantation, presence of extra-hepatic manifestations. In fact, patients with stage 4–5 chronic kidney disease have been increasingly recognized as priority patients to receive DAA, as endorsed by the 2018 updated KDIGO guidelines.[46]

We agree that patients should be screened for HIV infection before renal transplantation, although HIV infection is not considered a contraindication given the improved outcomes after highly active antiretroviral therapy. The largest study examined 150 carefully selected renal transplant recipients with CD4+ T-cell counts of at least 200/mm^3 and undetectable HIV RNA levels. Three-year patient and graft survival was 88% and 74%, respectively.[47] Remaining challenges include recurrence of HIV-associated nephropathy, high acute rejection rate and choice of donor kidneys.[48] As suggested by the Canadian guideline,[6] kidney transplantation in HIV-infected patients should only be performed in centres with extensive experience in managing both HIV infection and kidney transplantation.

Guideline 2.7

The overall risk of malignancy is markedly increased after renal transplantation, partly related to extent and duration of immunosuppression, concomitant viral infection, pre-transplantation dialysis, and rarely, donor origin. The observation has been consistent in local and worldwide setting.[49–51] Malignancy is one of the leading causes of death among kidney transplant recipients, and malignancy developing in solid organ transplant recipients is associated with worse outcomes.[50]

Although the clinical and economic impacts of malignancy diagnosed within the first 3 years of renal transplant have been shown to be substantial,[52] the clinical effectiveness of pre-transplant malignancy screening has not been convincingly confirmed. A reasonable strategy, intuitively, would be to ensure that patients are free from malignancy before wait-listing for transplant. Since there is no strong evidence that dialysis patients on the transplant waiting-list should have additional cancer surveillance strategies over that recommended for the general population, we follow the AST and European recommendation of age-appropriate screening tests of the general public.[5,18]

We recommend that renal transplantation should only be considered in patients with a history of malignancy (excluding non-melanoma skin cancer) if there is no evidence of persistent or recurrent cancer. While most guidelines recommend a waiting period free of recurrence from 2 to 5 years,[5–7] the recommendations are by and large empirical and should vary with individuals, preferably after discussion with treating team and oncologists. There is, for instance, suggestion that short waiting period (1 year in Norway) for kidney transplant recipients having a previous malignancy was not associated with increased mortality, by comparing 377 recipients with pre-transplant cancer and matched recipients without malignancy history.[53] On the other hand, we take note of other concern with higher incidence of post-transplant (de novo in addition to recurrent) malignancy in kidney transplant recipients with a history of malignancy before transplant.[54]

Guideline 2.8

Certain diseases are more likely to recur after transplantation when the disease activity remains high at the time of transplant. Examples include systemic lupus erythematosus and antineutrophil cytoplasmic antibody-associated vasculitis. Despite case reports of successful transplantation with active systemic lupus erythematosus,[55] for instance, it is probably prudent to wait for the disease to become quiescent before proceeding with transplantation.

Audit items

Kidney transplant recipient care varies considerably between centres. Steps to address identified gaps in treatment

outcomes include the agreement on and monitoring of uniform key performance indices.

For each renal transplant unit, these results should be benchmarked against international guideline standards in order to achieve the best possible results.

For all transplant evaluation centres, we recommend audit of the following indices:

- Proportion of transplant patients who receive a living donor transplant.
- Proportion of patients on the transplant waiting list with negative anti-HBc and have been immunized against hepatitis B virus.

DECEASED KIDNEY DONOR EVALUATION

INTRODUCTION

In Hong Kong, as well as Europe and the United States, donors of most kidneys are deceased. Until now, the risk of accepting a deceased kidney is higher than live donor kidney for recipients. To minimize complications, the selection of deceased kidney donors is important.

We draw references to international guidelines of evaluating cadaveric kidney transplantation, including the Caring for Australasians with Renal Impairment (CARI) guidelines[56] and more recent European Best Practice Guideline (EBPG).[4]

DECEASED KIDNEY DONOR

3. SCREENING FOR INFECTION

Guideline statements

3.1. We recommend risk assessment of donor-derived infection based on epidemiologic history, microbiologic testing and serologic tests for deceased kidney donors [D].

3.2. We recommend antibody detection for common infections by serologic tests as the first-line screening tool. Examples include Venereal Disease Research Laboratory (VDRL) test, HIV, CMV, EBV serologic tests [R].

3.3. Deceased donors with positive EBV, CMV or VDRL serologic tests can be considered for kidney donation provided that appropriate monitoring and/or treatment is available.

3.4. We recommend screening deceased donors for hepatitis virus by hepatitis B virus surface antigen (HBsAg), hepatitis B virus core antibody (anti-HBc) and hepatitis C antibody (anti-HCV). We recommend use of HBsAg positive kidneys for HBsAg positive recipients [R].

3.5. We recommend risk assessment of immune recipients (anti-HBs < 10 IU/L) who receive kidneys from isolated anti-HBc positive donors (anti-HBc + HBsAg-donors), but there is no strong evidence for hepatitis B immunoglobulin [D].

Background

Donor-derived infections are a rare but significant complication in kidney transplant recipients; the risk of donor-derived infection should be minimized by donor screening, and if necessary, prophylaxis for recipients.

Rationale

Guidelines 3.1 and 3.2

In view of limited time window for screening deceased donor infection (before organ procurement), the recommended tests are in general referring to antibody detection by serologic tests.[57]

Sensitivity of serologic tests is limited by their inability to detect acute infection (before seroconversion). Augmented screening tools such as molecular and rapid assays should be limited to special cases and depend on epidemiological and regional risks. In case of doubt, the transplantation of organs from deceased donors with unexplained fever and encephalitis, or untreated infection should be balanced with the urgency of transplant need.

Guideline 3.3

EBV seropositive status is not a contraindication to kidney donation,[55] although it can confer an increased risk of primary infection and PTLD, particularly if the recipient receives prolonged or repeated courses of antilymphocyte therapy.

The implication of CMV seropositive kidney donor is the intensification of monitoring and pre-emptive prophylaxis strategy. Donor and recipient CMV (anti-CMV IgG) status are key predictors of infection risk and management. There is strong recommendation for either prophylaxis or pre-emptive therapy after kidney transplantation with CMV D +/R− situation.[40]

Based on case reports and expert opinion, transmission of syphilis from VDRL positive donor can be minimized by a 2-week course of penicillin treatment (two doses of intramuscular 2.4 MU benzathine penicillin a week apart, or an equivalent early syphilis treatment, given as soon as possible after transplantation) to the recipient after obtaining consent.[55,58]

Guidelines 3.4 and 3.5

The primary goal of testing the hepatitis B and C viruses is to guide the use of organs infected. In general, kidneys infected with the hepatitis B and C viruses are reserved for recipients infected with the respective hepatitis virus.[57]

Use of kidney organs from anti-HBc+ HBsAg− kidney donors is not contraindicated because the risk of hepatitis B virus transmission is considered low.[59] Observed rate of HBsAg acquisition was 0.28% (with no evidence of symptomatic hepatitis) in a review of 1385 HBsAg negative kidney recipients from anti-HBc+ donors.[60] Although antiviral prophylaxis for up to 1 year[59] may be considered in susceptible kidney recipients (anti-HBc− anti-HBs−), we do not make strong recommendation because of the low quality of evidence. Target anti-HBs titre is not well defined, although anti-HBs titre greater than 100 IU/L might have better protection than the usual anti-HBs target of 10 IU/L. A case series of kidney transplant from anti-HBc positive donor showed that the risk of anti-HBc seroconversion was 10% when the recipient anti-HBs titre was less than 100 IU/L, compared to 4% when greater than 100 IU/L.[61] The need of antiviral prophylaxis should be individualized and depends on the risk of reactivation such as rituximab use. On the other hand, the use of antiviral prophylaxis is not indicated in kidney recipients with natural (anti-HBc+ anti-HBs+) or vaccine (anti-HBc− anti-HBs+) immunity.

4. SCREENING FOR MALIGNANCY

Guideline statements

4.1. We recommend screening potential deceased kidney donors for malignancy [D], although the risk of donor transmission of malignancy has to be weighed against the risk to the potential recipient of not receiving the organ.

4.2. We recommend against the use of deceased kidney donors with potentially metastasizing malignancy [R].

Background

The rationale of screening deceased donor is to minimize risk of donor transmission of malignancy, although there are no absolute contraindications.[62] The risk of transmission among deceased donors with a prior history of malignancy (but tumour-free at the time of donation) is also recognized. This is an area with knowledge gap, and little international consensus. A systematic review recommended against accepting a kidney from donors with a history of melanoma and lung cancer.[63]

We are not aware of any recommendation on the extent and methodology of screening for malignancy among deceased donors. Besides history taking and clinical examination, the CARI guidelines suggested thorough examination of organs at the time of retrieval and frozen sections taken of any suspicious lesions.[56]

Rationale

Guidelines 4.1 and 4.2

Current information about the donor transmission of malignancy is largely derived from the Israel Penn International Transplant Tumour Registry (IPITTR), the United Network for Organ Sharing (UNOS)/the Organ Procurement and Transplant Network (OPTN).[62,64,65] With the caveats of voluntary reporting and incomplete database and thus overestimation of donor transmission risk, the high-risk tumours reported for transmission included choriocarcinoma, malignant melanoma, lung cancer, renal cell carcinoma (which is almost exclusively confined to the renal allograft). Transmissibility of certain tumours is considered extremely low; they include localized, early-stage prostate cancer and T1 colon cancers and a minimum of 1-year disease-free interval. The term 'donor-derived malignancy' is now less commonly used and has been replaced by 'donor-transmitted malignancy', referring to one that was present (or presumed present) as a tumour growth in the donor prior to transplant. We take note of the discussion and recommendation by the Disease Transmission Advisory Committee (DTAC) Malignancy Subcommittee from the OPTN.[66] Risk categorization framework for donor malignancy transmission, from the lowest group (frequency estimate ≤0.1%) to high risk group (>10%), should be considered. For example, use of elderly donors raised the concern of transmitting prostate carcinoma, but transmission of prostate cancer through kidney transplantation was considered unlikely based on follow-up data.[66] The most effective evaluation of deceased donor with past history of malignancy (other than lung and melanoma) is unknown. The minimum duration of disease-free survival has not been determined. In general, donors with a history of treated cancer 5 or more years earlier and with a probability of cure of more than 99% are considered at low risk for transmission.[66] The benefits and risks need to be discussed on a case-by-case basis.

We are aware of the risk of remaining on the waiting list for transplant and thus the consideration of marginal graft kidney such as those with small renal cell carcinoma that were treated by partial nephrectomy and had low recurrence risk.[67] The threshold of accepting potential risk remains debatable because registry data has highlighted the increased risk of malignancy among recipients of expanded criteria deceased donors or deceased kidney recipients.[68,69]

5. SCREENING FOR DONOR KIDNEY QUALITY

Guideline statements

5.1. We recommend radiographic imaging of potential deceased donor's kidneys if there is a history of kidney

stones, urological anomalies or family history of polycystic kidney disease [R].

5.2. We recommend balancing the trade-off of using expanded criteria kidney donor, taking into consideration the recipient age [D].

Background

There is less concern with the kidney anatomy than the function of deceased donor kidneys. The literature supports the finding of worse long-term outcome of using expanded criteria donors (ECDs), and this is more pronounced among young kidney recipients.[70] Currently accepted definition of ECD refers to either (i) deceased donors age more than 60 years old or (ii) deceased donors age more than 50 years old with at least two of three criteria: hypertension, death attributed to cerebrovascular accident or terminal serum creatinine of greater than 132 μmol/L.[71]

Rationale

Guideline 5.1

There is no consensus on whether routine preoperative imaging is cost-effective to detect donor-derived kidney stone.[72] Observational studies suggest a low prevalence,[73] although anatomic evaluation by computed tomography is often advised in live donors.[74] There is no strong recommendation to screen every deceased donor for kidney stones or structural abnormality. However, given the relatively low risk of harm by ultrasound assessment, the application of routine imaging may still be considered for potential donors.

Guideline 5.2

The CARI guidelines recommend that procurement of grafts from ECD should continue to be actively pursued,[56] as has been endorsed by the ERA-EDTA-Developing Education Science and Care for Renal Transplantation in European States working group to be a strategy to increase donor pool and access to kidney transplantation.[75] This should be undertaken with age-matching criteria because the goal is to derive the most benefit from ECD kidney in terms of patient survival[69,75] and to reduce the waiting time in elderly waitlisted patients.

Another approach to ECD is surgical assessment during procurement and histological assessment by donor kidney biopsy.[56] Retrospective studies and most experts suggest that histology finding of glomerulosclerosis and interstitial fibrosis are predictive of graft outcomes.[76] Despite the recommendation of donor biopsy, there is remarkably little prospective data to support routine biopsy. In addition, problem of reproducibility in the biopsy finding may limit its use.[77] A European large-scale prospective analysis of ECD kidneys (2763 consecutive recipients in the principal cohort and 4128 in the validation cohort) reported that pre-implantation biopsy assessments did not have independent and additional predictive ability for long-term kidney outcome when considering cold ischaemia time and circulating donor-specific antibody .[78]

Concerns regarding the dichotomous definition of ECD have led to the recent introduction of a continuous index to quantify the quality of donor kidneys, namely, the Kidney Donor Profile Index.[79] The index captures a variety of donor risk factors for graft failure to estimate the projected graft lifetime, and represents a potential tool to assist decision.

6. DUAL KIDNEY TRANSPLANT

Guideline statements

6.1. En bloc transplantation of kidneys from paediatric donor should be considered before discarding due to low donor age. We recommend using en bloc transplantation for donors weighing less than 10 kg [D].

Background

The scarcity of organ should increase the threshold of discarding kidneys from cadaveric donors. Dual transplantation should be considered an option to expand the donor pool. This is feasible and the risk–benefit ratio needs to be assessed in the context of the recipient, with or without donor kidney biopsy.

Rationale

Guideline 6.1

Most case series of en bloc transplantation of paediatric kidneys to adults involved donors between 12 and 24 months, weighing 10–20 kg, followed by serial increase of kidney size with time.[80] Similar, or even better, long-term outcomes have been demonstrated when compared with living donors, with the caveats of early surgical complication. Preferred choice of recipients is those with body size less than 70 kg.[81]

On the other hand, there is no high-quality evidence to support dual kidney transplant for ECD kidneys. A literature review showed that, when strictly allocated according to reliable clinical or histological scores, dual and single ECD transplantations yield similar patient and graft survival results.[82]

KIDNEY TRANSPLANT POST-OPERATIVE CARE

INTRODUCTION

Kidney transplantation is the preferred form of renal replacement therapy for end-stage renal disease, but there

are specific challenges for this treatment. To this end, several major kidney organizations have provided guidelines on the issue of kidney transplant care.[83–85]

Renal transplant care is in general provided by nephrologist postoperatively in Hong Kong, but collaboration with urologists and multi-disciplinary team approach remain crucial. To avoid duplication of effort, we made reference to the previous guidelines and adapt for the transplant recipient care service in Hong Kong.

POST-OPERATIVE CARE

7. POST-OPERATIVE EDUCATION

Guideline statements

7.1. Patients with kidney transplant should receive timely education about self-care and medication management [R].

7.2. Education should extend beyond the early period of hospital stay, and in longer term after transplant with preferably regular updates or repeated education tailored to the patients' needs [D].

Background

Patient education is essential for kidney transplant recipients. The information should be related to medication use after transplant surgery, healthy lifestyle, self-management skills, return to work and emotional coping. Nonetheless, there are no minimum standards for education after kidney transplant. Although little controversy surrounds the indication of patient education, the frequency of education is unknown.

Rationale

Guidelines 7.1 and 7.2

Renal transplant recipients have special education needs in view of the complexity of drug protocol, interaction and narrow therapeutic windows of many immunosuppressive medications. One measurement of patient health literacy after renal transplant refers to their knowledge of their medications by name, dosage, reasons for prescription, adverse effects and precautions.[86] Individual counselling, group education, written material and visual aids are appropriate for patients.

Growing body of literature also suggest the need for repeated education of patients as a result of worsening adherence over time after transplant. The trend of worsening adherence has been replicated in multiple studies and surveys,[87,88] although the risk can sometimes be predicted by non-adherence behaviour as early as the first 2 months.[88]

In addition to the education of proper medication use, renal transplant recipients should receive education on recognition of infectious complications, lifestyle modification and exercise. Change in knowledge and attitudes after educational intervention, for instance, has be shown to improve the sun protection behaviour, and supported by biologic measures of less skin darkening by spectrophotometry, in a randomized controlled trial.[89] Education on lifestyle modification is the standard of care to prevent diabetes and other metabolic complications. Arguably, this is extrapolated from studies in general population[90] instead of transplant recipients. Results on strategy of dietitian education, graded exercise program and advice on weight loss has remain limited, but provide early evidence to attenuate or reverse the progression of glycaemic dysregulation after transplant.[91]

8. DRUG ADHERENCE

Guideline statements

8.1. Patients should be screened for non-adherence to minimize the risk of acute rejection and kidney graft loss [R]. In the absence of perfect tool to assess adherence, the team can consider self-reporting by patient, collateral information from family or caretakers, drug monitoring or biological markers, electronic monitoring or refill/prescription records.

8.2. Multidimensional interventions targeting behavioural risk factors or a combination of behavioural, educational and emotional changes are the preferred strategy to improve adherence [D].

Background

Medication adherence, especially immunosuppressive medication, is a key target in improving transplant long-term outcomes. Non-adherence has been shown to be common in the first months after kidney transplantation, and increase by duration of follow up, and more so during the transition from adolescent to young adult.[87,92,93]

Rationale

Guidelines 8.1 and 8.2

A systematic review found a lack of studies powered to detect difference in graft rejection or loss after intervention on non-adherence.[94] On the other hand, there are moderate-quality evidence that medication adherence is enhanced with multidimensional interventions, instead of one-off feedback from a nurse or financial assistance program.[94]

Barriers to effective adherence enhancement include the multifactorial causes of non-adherence. Providing medical information alone is unlikely sufficient to translate into patients' behavioural change. Knowledge alone is not the

solution to change adherence behaviour. A systematic review of 50 qualitative studies on patient attitudes to self-management also confirmed that medical adherence is not merely an issue of patient's knowledge.[95] More detailed analysis showed that kidney transplant recipients who scored low on goal importance were more likely to become non-adherent over time.[87] Motivational interview and emphasis on setting personal goal are suggested. Randomized controlled trial has shown improvement of medication adherence by behavioural contracts among kidney transplant recipients.[96]

TRANSPLANT MEDICATION

9. MAINTENANCE IMMUNOSUPPRESSION THERAPY

Guideline statements

9.1. If steroid is used beyond the first week after transplantation, it should preferably be continued instead of being withdrawn [D].

9.2. If calcineurin inhibitor (CNI) is used, it should be preferably continued in long term, unless for human leukocyte antigen (HLA)-identical monozygotic twin kidney donation [R].

9.3. Mammalian target of rapamycin inhibitor (mTORi) is an acceptable option of primary immunosuppression therapy [D], if there is no delayed graft function, lymphocele or poor wound healing.

9.4. The maintenance medication should be tapered to the lowest planned doses by 4–6 months after transplantation [R], if there has been no acute rejection.

Background

We agree with the KDIGO[83] and KHA-CARI[84] guidelines that high doses of immunosuppression should be targeted when the risk of acute rejection is highest (in the first 4 months), followed by reducing doses to optimize the graft function to minimize the risk of long-term complications (such as infection, nephrotoxicity or malignancy).

Rationale

Guidelines 9.1 and 9.2

There is no ideal immunosuppression regimen, but a meta-analysis showed a higher risk of acute rejection and graft failure after steroid withdrawal. CNI withdrawal, similarly, confers a higher risk of acute rejection (but not graft failure).[97] In patients with a low immunological risk profile, rapid steroid withdrawal has been nevertheless shown to be achievable after basiliximab or rabbit antithymocyte globulin induction therapy, with less post-transplantation diabetes.[98]

Guideline 9.3

As mentioned, the optimal immunosuppressive regimen remains unclear. A Cochrane meta-analysis and systematic review for the use of mTORi in primary immunosuppressive regimens for kidney transplant recipients showed no major differences in the hard end points of patient and graft survival in any comparison.[99] The concern that mTORi may induce certain toxicity (lymphocele, bone marrow suppression, lipid disorder) needs to be balanced with the potential benefit (such as reduced CMV infection).

Guideline 9.4

Several studies, including the ELITE-Symphony Study,[100] supported a lower level exposure to maintenance immunosuppression around 4 months after transplantation. No clear consensus exists for adjustment of medication during active infection (such as withholding one antimetabolite) except the preferred choice to withhold all immunosuppression (other than low-dose steroid) in life-threatening infection.

10. MONITORING IMMUNOSUPPRESSION THERAPY

Guideline statements

10.1. Cyclosporine A (CsA) plasma or whole-blood levels should be monitored using trough (C_0) or 2-h post dose (C_2) [D]. If C_2 level monitoring is chosen, the 'window of opportunity', 15 min before and after the 2-h time point, should be adhered to. Tacrolimus and mTORi levels should be monitored [D].

10.2. When there is a need to contain drug costs by generic immunosuppression, we suggest use with caution and close monitoring of the blood levels after medication switch of from the brand-name (original patented) version to generic ones [D].

Background

The principal rationale of therapeutic drug monitoring for immunosuppressive drugs is to minimize risk of underdosing (and hence risk of acute rejection or graft loss) and overdosing (related to toxicity such as nephrotoxicity). However, there is inadequate data from randomized controlled trials[101] to define the optimal target drug levels during different period of renal transplant.

Rationale

Guideline 10.1

No recommendation can be made on selecting between trough (C_0) and C_2 monitoring for CsA because no significant effect on the incidence of acute rejection or adverse events had been shown in randomized controlled trials.[102] Quality of comparative studies in the area of C_0 *versus* C_2 CsA monitoring in kidney transplant is considered poor (and largely limited to de novo transplant patients and much less in long-term transplant recipients) according to a systematic review.[103] The centres should consider the practical limitation of C_2 blood test (strict timing) before the decision on the best strategy of CsA monitoring. Therefore, the choice of CsA blood level timing should be based on individual centre's preference and on the patient's need (such as the need of trough blood level for other immunosuppression drugs). We recognize the occasional need of additional timepoints for monitoring although the uptake of an abbreviated area under the curve estimation ($AUC_{0\text{-}4}$) is in general low for practical (difficult-to-implement) reasons.

However, there are few trials that directly compare the effects of different levels of the same CNI. Optimal blood levels of tacrolimus, for instance, remain to be investigated although the ELITE-Symphony Study[100] suggested a lower dose of tacrolimus, defined as C_0 of 3–7 ng/mL, instead of 5–15 ng/mL.

We do not recommend routine monitoring of mycophenolic acid (MPA) blood levels because meta-analysis of randomized controlled trials[104] did not demonstrate benefit from controlled-dose of mycophenate mofetil based on MPA therapeutic monitoring in kidney transplant recipients.

Guideline 10.2

Meta-analysis of randomized trial results in kidney transplantation[105] showed that generic cyclosporine, tacrolimus and mycophenolate mofetil did not meet the European Medicines Agency (EMA) or Health Canada criteria for bioequivalence. There was no significant difference in acute rejection, but the methodological quality of most studies was poor.[105]

Besides, generic drugs must demonstrate bioequivalence, but not necessarily therapeutic equivalence, to their brand-name counterparts before approval. Bioequivalence is established on the basis of the maximum serum drug concentration, the time until the maximum concentration is reached, or the area under the curve based on serum concentration as a function of time. Ideally, a generic formulation of immunosuppressive drug should provide the same systemic exposure in steady state. This needs to be further confirmed, but a randomized cross-over study[106] showed a different pharmacokinetic profile in generic tacrolimus, for instance. In terms of therapeutic effect (as opposed to biological effect), some physicians have expressed concern that generic immunosuppression medication are less effective. Based on a retrospective study on the outcomes in de novo kidney transplant recipients, generic formulation of CsA had been associated with higher acute rejection rate and severity.[107] For patients on maintenance immunosuppression treatment, on the other hand, no study had been powered to demonstrate the safety of generic drug. A sample size of 2000 patients would be expected in such non-inferiority trial.[108]

Similar to the position statement of the Canadian Society of Transplantation,[109] we believe caution is warranted in the use of generic immunosuppression drugs in kidney transplant recipients, and should be substituted only after informed consent.

11. ACUTE REJECTION

Guideline statements

11.1. Acute rejection should be confirmed by biopsy before treatment unless the biopsy is absolutely contraindicated or causes significant delay of treatment [R].

11.2. In case of acute cellular rejection, high dose steroid is recommended as the initial treatment [R], followed by consideration of escalating the baseline immunosuppression.

11.3. In case of acute antibody-mediated rejection (AMR), plasma exchange and/or intravenous immune globulin should be considered the first-line treatment [D].

Background

In general, kidney graft biopsy is recommended for all patients with deterioration in kidney function. The rationale is to detect potentially reversible causes, one of them being acute rejection. Repeated kidney biopsy is also indicated if there is concern with inadequate reversal of the rejection process with treatment.

Rationale

Guideline 11.1

We recommend graft biopsy to confirm rejection instead of empirical treatment, because acute rejection can be mimicked by conditions like recurrent kidney disease or BK virus-induced nephropathy. In view of competing diagnosis, risk of infection and malignancy from high-dose immunosuppression therapy, histological evidence of acute rejection should be sought.

Guideline 11.2

Evidence from randomized trials on the most effective strategy for treating acute cellular kidney rejection is lacking, but practice guidelines recommend the use of pulse steroid as

the first-line treatment. Other treatments of choice include anti-T-cell antibody (polyclonal antibody like horse or rabbit antithymocyte globulin), non-antibody therapy (like tacrolimus, mycophenolate mofetil and increasing the dose of existing drug). One early randomized controlled study has demonstrated the benefit of converting patients on CsA to tacrolimus after the first biopsy-proven acute rejection, as shown by more significant resolution of the acute rejection episode and less recurrent rejection at 3 months.[110]

Guideline 11.3

Acute AMR carries a high risk of allograft loss or of residual damage. The treatment aim of AMR is to remove or block the action of circulating donor-specific anti-HLA antibodies, reduce their production or both.[111] As such, plasma exchange (antibody clearance) and intravenous immune globulin (B-cell modulating therapy) remains the mainstay of treating AMR, whereas use of rituximab (B-cell depletion and possibly suppressing alloantibody production), bortezomib (plasma cell depletion) and eculizumab (complement inhibition) have not been shown to improve long-term outcome. As highlighted by the KDIGO guideline[83] and an updated systemic review and meta-analysis,[112] evidence from randomized trials adequately powered to determine the safety and efficacy of treatment strategies for AMR is lacking. Most of the randomized controlled studies are designed for testing antibody removal, despite important heterogeneity in treatments, definition of AMR, quality and follow up. A recent randomized double-blind study showed that adding rituximab to plasma exchange, intravenous immune globulin and corticosteroid did not significantly improve allograft function or survival at day 12 and at 1 year.[113] Data from randomized trials are also lacking to guide the management of chronic AMR. Plasma exchange and intravenous immune globulin, in short, remain the standard of care for AMR[112]; no therapeutics have yet received Food and Drug Administration (FDA) approval for the treatment of AMR.[111]

12. GRAFT DYSFUNCTION

Guideline statements

12.1. Causes of worsening transplant kidney function should be evaluated, with emphasis on CNI toxicity, recurrent or de novo kidney disease, urinary obstruction, BK polyomavirus (BKV) disease, vascular causes and chronic rejection [D].
12.2. When there is chronic allograft injury and histological evidence of CNI toxicity, introduction of mTORi to reduce or replace CNI can be considered for patients [D] with graft estimated glomerular filtration rate (eGFR) more than 40 mL/min per 1.73 m^2 and proteinuria less than 0.8 g daily.
12.3. When the graft eGFR is less than 20 mL/min per 1.73 m^2, advanced kidney care or low clearance clinic provision should be available, aiming at joint discussion of dialysis plan (and re-transplantation if appropriate) 6–12 months ahead [R].
12.4. Decision on the maintenance and withdrawal of immunosuppression should be individualized, and depend on the risk of immunosuppression and likelihood of pre-emptive transplant (or re-transplantation within short period of time) [D].

Background

Kidney biopsy is often indicated to define the causes of deterioration in graft function or proteinuria.

Rationale

Guideline 12.1

Kidney biopsy is often indicated to define the causes of deterioration in graft function or proteinuria. Screening for BK polyoma virus with quantitative plasma nucleic acid testing (sometimes by urine polymerase chain reaction (PCR)-based detection of BKV or urinary cytology) has been recommended but there is no consensus on the frequency and approach (such as after augmenting immunosuppression or if renal dysfunction).[114] Data are also lacking on the threshold of BKV load for justifying reduction of immunosuppression. Moreover, prospective BKV screening protocol with immunosuppression reduction has been shown to reduce, but not necessarily eliminate, the risk of graft loss.[115] Strongest data for screening and pre-emptive immunosuppression reduction come from a single-centre study, in which 200 patients were randomly assigned to either tacrolimus or CsA, and were monitored with PCR of blood and urine to detect early BK viruria and viraemia. Reduction of immunosuppression (discontinuation of mycophenolate or azathioprine) was attempted after detection of viraemia. Five-year follow up suggested that minimization of immunosuppression upon detection of BK viraemia is associated with excellent graft survival, low rejection rates and preserved renal function.[116]

Guideline 12.2

After excluding reversible injury, most importantly by kidney biopsy, it is reasonable to manage chronic allograft injury by minimization of CNI toxicity. Mixed results have been shown for the use of mTORi in clinical trials[117,118] whereas systematic review of randomized controlled trials[118] suggest that patients with late conversion to mTORi up to 1 year post-transplant in intention-to-treat analysis had higher eGFR. The benefit for 2–5 years after transplant is valid for on-treatment analysis only.[118] Longer-term follow-

up data is still lacking but the risk of acute rejection was higher in patients converted to mTORi.[119,120] Furthermore, concern about CNI nephrotoxicity has been recently superseded by the suggestion of chronic antibody-mediated damage being the main cause of late graft loss.

Another crucial aspect in mTORi use is the post hoc subgroup analysis showing harm in converting patients with eGFR 20–40 20 mL/min per 1.73 m^2.[116] Besides eGFR, proteinuria at the time of conversion has also been shown to be predictive of treatment success[121]; we agree to avoid mTORi conversion among kidney transplant recipients with proteinuria exceeding 0.8 g daily.

Guideline 12.3

The management of failing graft kidney is extrapolated from that of native kidney with chronic kidney disease. The benefit of various intervention such as strict blood pressure control and the use of angiotensin-converting enzyme inhibitor or angiotensin receptor blocker have not been tested specifically in this population. In a (albeit underpowered) randomized placebo-controlled trial, the use of ramipril was not shown to improve the hard renal end points (doubling of serum creatinine, end-stage renal disease or death) among renal transplant recipients with proteinuria.[122]

Key elements of joint kidney care include psychological support, treatment of cardiovascular risk, anaemia management, discussion about dialysis plan, access creation and exploration of transplant prospect.

Guideline 12.4

Data are lacking from randomized trials or national database on the most effective strategy for immunosuppression drug management in kidney transplant recipients with a failed graft.[123]

In general, immunosuppression drugs are tapered and then withdrawn in patients who have returned to dialysis. Some might benefit from continuation of immunosuppression. Treatment priority should be given to those who have higher risk of sensitization. Other considerations to support continuation of immunosuppression include preservation of residual renal function, avoiding acute rejection and reactivation of primary systemic disease (such as systemic lupus erythematosus), prevention of graft intolerance syndrome.

Limitations

The available evidence does not provide clear recommendations about the treatment protocol of acute rejection. A pragmatic approach is to balance the risk of immunosuppression and infection. Rather than stating what we know about treating rejection and especially chronic AMR, our guideline serves the purpose of highlighting what we do not know, thus justifying for new research plan and funding agencies to support efforts that will close evidence gaps.

Audit items

Kidney transplant care and standards vary considerably between centres. Steps to address identified gaps in treatment outcomes include the agreement on and monitoring of uniform key performance indices.

For each renal transplant unit, these results should be benchmarked against international guideline standards in order to achieve the best possible results.

For all transplant centres, we recommend regular audit of the following indices[124]:

- Graft survival at 1, 3 and 5 years
- Rejection rate
- Patient survival at 1, 3 and 5 years

Abbreviations

ACC	American College of Cardiology
AHA	American Heart Association
AMR	antibody-mediated rejection
anti-HBc	hepatitis B virus core antibody
anti-HBs	hepatitis B surface antibody
AST	American Society of Transplantation
BKV	BK polyomavirus
BMI	body mass index
CAC	coronary artery calcium
CARI	Caring for Australasians with Renal Impairment
CCTA	coronary computed tomography angiography
CMV	cytomegalovirus
CNI	calcineurin inhibitor
CsA	cyclosporine A
PCR	polymerase chain reaction
DTAC	Disease Transmission Advisory Committee
EBPG	European Best Practice Guideline
EBV	Epstein Barr virus
ECD	expanded criteria donor
eGFR	estimated glomerular filtration rate
ERA-EDTA	European Renal Association – European Dialysis and Transplant Association
GFR	glomerular filtration rate
HBsAg	hepatitis B virus surface antigen
HBeAg	hepatitis B e antigen
HBV	hepatitis B virus
HIV	human immunodeficiency virus
IPITTR	Israel Penn International Transplant Tumor Registry
KDIGO	Kidney Disease: Improving Global Outcomes

MPA	mycophenolic acid
MPS	myocardial perfusion scintigraphy
mTORi	mammalian target of rapamycin inhibitor(s)
OPTN	Organ Procurement and Transplant Network
PTLD	post-transplant lymphoproliferative disease
USRDS	United States Renal Data System
VDRL	Venereal Disease Research Laboratory

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Supplement Article

Clinical practice guidelines for the provision of renal service in Hong Kong: Renal Nursing Practice

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Scope of Guideline

This guideline addresses issues relevant to nursing practice in the renal specialty in both public and private sectors in Hong Kong. This serves as a guide for nurses to provide quality care in meeting the required standards of practice in renal services.

I INTRODUCTION

Professional nurses are accountable for their independent patient assessment, care planning, implementation and evaluation of interventions, in providing the holistic care to achieve the best possible rehabilitation. Renal nurses in Hong Kong are committed to provide quality care to our clients. Hence, continuous effort to evaluate professional competencies and to maintain up-to-date knowledge is deemed necessary to pledge for the high standard of service. The 'Guidelines for Specialty Nursing Service – Renal Nursing' and the 'Advanced Nursing Standards for Patient Care' that are published by Hospital Authority in 2015 are some of the important references to guide local renal nursing practices. This paper aims to describe renal nursing practice in Hong Kong. There are three specific objectives include: (i) to provide guidelines for practice and policy making within the specialty, (ii) to identify areas for evaluation on care and practice standards and (iii) to facilitate quality assurance in renal patient services.

II NURSING AND STRUCTURAL REQUIREMENT

1. The nurse-in-charge of the renal unit is responsible for: (D)
   - 1.1. directing the resources including human and material resources required for the smooth running of the unit;
   - 1.2. planning for the expansion and growth of the unit in response to the changing needs of the community;
   - 1.3. promoting continuous nursing development to accommodate the technological advancement;
   - 1.4. monitoring the performance of the staff and ensuring provision of quality care to renal patients;
   - 1.5. ensuring the availability of emergency services such as laboratory service and acute haemodialysis service can be provided in designated/affiliated institutions;

1.6. representing the unit to liaise with other institutions/organizations.

2. The nurse-in-charge of an accredited renal centre should be a registered nurse (general) at the Nursing Council of Hong Kong and has completed a post-registration renal nursing program. The nursing staff working in the centre is renal specialty trained either through on the job training or a formal structured program. All new comers should undergo a structured and comprehensive orientation program. Hospital/organizational policies, nursing practices requirement, renal specialty standards and guidelines should be in place. (R)
3. The renal nurse works collaboratively with other health-care professionals to provide safe, competent and high-quality care in a cost-effective manner. All nurses working in renal centres should attend relevant courses, seminars or conference to update their knowledge and to keep pace with the advance in care and technology. Reference materials should be available in the renal centre. (D)
4. A renal nurse is recommended to attain "Continuous Nursing Education" points (45 points in 3 years) in line with the policy of the Nursing Council of Hong Kong, whereas a minimum of 40% annual CNE points should relate to renal specialty.[1] (D)

III SUGGESTIONS FOR RENAL SPECIALTY TRAINING PROGRAM

1. All post-graduate renal nursing programs should be conducted in a recognized training institution with the relevant expertise. There should be significant input from qualified nurses experienced in renal specialty in the design of curriculum, the teaching and the evaluation of the course. The majority of the lectures and theoretical input should be related to renal nursing competencies, and there should be at least 50% nursing input in the theory section. (D)
2. The nurse caring for dialysis patients is recommended to attend a structured training course that consists of a minimum of: (1) 28 h theoretical input for haemodialysis and 7 h for peritoneal dialysis and (ii) 80 h of practical haemodialysis training through clinical attachment to an accredited renal centre. An additional 80 h of peritoneal dialysis (PD) practicum will be required for nurses working with peritoneal dialysis. (R)
3. The number of specialty-trained nurses working in the renal unit should be more than 70% of the total nursing workforce in the renal specialty. (D)

IV SUGGESTIONS FOR DIALYSIS NURSING MANPOWER

The Nurse: Patient ratio will depend on the patient's dependency level.[2] The reference ratio is 1:1 for haemodialysis in critical care setting, 1:2 for acute haemodialysis in hospital, 1:3 for chronic haemodialysis in hospital and 1:4–5 in the community haemodialysis centres. It should have adequate qualified renal nurses taking care of the dialysis patients in each shift of duty. Technical service assistants or dialysis assistants could assist nurses in providing care to renal dialysis patients. As for home therapy, the suggested Nurse: Patient ratio is 1:20 for home haemodialysis and 1:40 for home PD. (D).

V COMPETENCY, GUIDELINES AND STANDARDS OF PRACTICE

Guidelines and standards in renal specialty provide a guide to enable nurses to deliver safe, efficient and cost-effective care.[3] Advanced Nursing Standards for Renal Care should be available and these standards provide a basis to guide nursing practice in renal specialty. However, provision of competent and high-quality care to clients requires the stringent control within the profession.[4–6]

V(i) Standards of Practice

The standards of practice act as a guide for professional renal nurses.[7,8] According to professional nursing practice, the renal nurse:

1. functions in accordance with legislation, common laws, organizational regulations and by-laws, which affect nursing practice;
2. provides care to meet individual client's needs on a continuum basis and delivers care ethically;
3. practices current renal nursing care competently;
4. demonstrates accountability for his/her professional judgement and actions;
5. creates and maintains an environment, which promotes safety and security of clients, families and staff;
6. masters all essential equipment and supplies, and uses available resources for care of renal clients;
7. minimizes and prevents clients from infection;
8. performs health assessment accurately, systematically and continuously;
9. identifies problems and plans care in collaboration with the client, family and other health-care team members;
10. implements planned nursing care to achieve identified goals;
11. evaluates the outcomes of nursing care;
12. promotes and provides health education for clients, families and the public;
13. collaborates with other health-care team members to promote client's rehabilitation;
14. acts to enhance the professional development of self and others;
15. integrates research findings into nursing practice.

Remarks: Statements no. 8–11 should be read together as they describe interrelated steps in the nursing process by which a competent level of nursing care is demonstrated.

V(ii) Guidelines for Renal Nursing Practice

There are guidelines for renal nursing practice in different arena.[2,4–6,8] The following 14 guidelines direct the practices of renal nurses in four major categories.

A. **Haemodialysis**

1. Care of patient for insertion of percutaneous catheter for haemodialysis
2. Care of patient for creation of arteriovenous (AV) fistula or autologous/synthetic graft
3. Care of patient on haemodialysis
4. Care of patient on on-line haemodiafiltration
5. Nocturnal home haemodialysis (NHHD) patient training

B. **Peritoneal dialysis**

6. Care of patient for insertion of peritoneal catheter
7. Care of patient on peritoneal dialysis
8. Care of patient with peritoneal dialysis access
9. PD patient training

C. **Renal transplantation**

10. Pre-operative care of patient for renal transplantation
11. Post-operative care of patient for renal transplantation

D. **Special procedures and infection control**

12. Care of patient on charcoal perfusion (charcoal haemoperfusion)
13. Care of patient on therapeutic plasma exchange (TPE)
14. Nursing role in infection control in renal dialysis unit

VI NURSING AUDIT

Nursing audits provide an official means of checking the process of nursing care delivery in an objective manner and in accordance to the established standards and guidelines.[5] Audit checklists can incorporate individual renal unit's protocol into the checklist to enable comprehensiveness in the audit process. Compliance and non-compliance data can be used in quality improvement projects and serve as benchmark of service provision. It is recommended to conduct nursing audit at least once every 12 months (refer to individual guideline for the audit items).

VII CONCLUSION

The renal dialysis centres in Hong Kong should conform to the agreed health policies and safety guidelines. The Standard of Practice and the Guidelines for Renal Nursing Practice are important establishment to guide renal nursing practice. It is recommended to conduct nursing audits in renal care regularly. In summary, the adoption of the Standards and Guidelines can facilitate quality assurance in renal nursing practice. All renal centres should strive to implement quality assurance program so as to enhance nurses to provide safe, efficient, cost-effective and high-quality renal services.

VIII ACKNOWLEDGEMENT

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1. CARE OF PATIENT FOR INSERTION OF PERCUTANEOUS CATHETER FOR HAEMODIALYSIS

Introduction

Percutaneous HD catheters are commonly used in patients with acute kidney injury (AKI), patients with chronic kidney disease (CKD) presenting late; and patients on chronic PD with complications requiring urgent renal replacement therapy (RRT) in the form of temporary haemodialysis.

Renal nurses have to provide appropriate and safe care to patients with HD catheters in order to minimize catheter dysfunction and complications, so as to maximize the efficacy of the treatment.

Guideline Statements

1. We recommend implementation of catheter bundle care and standard precautions in the care of patient for insertion of percutaneous catheter. (R)
2. We suggest percutaneous catheters should only be used for acute dialysis in a limited period of time. In chronic dialysis patients, the catheters should be used in conjunction with a plan for permanent access creation. Insertion of percutaneous catheters should be avoided if possible. (D)
3. Assess and evaluate the physical condition, past health history and allergy history before insertion of percutaneous catheter. (D)

4. We recommend that informed consent is mandatory. (R)
5. Provide information on the procedures to patients and their families. (D)
6. Provide psychological support and counselling to patients and their families. (D)
7. Prepare the environment, required accessories and equipment for insertion of percutaneous catheters. (D)
8. Administer medications as prescribed including catheter lock. (D)
9. We recommend to evaluate the intraoperative complications, delayed complications and mechanical failure after insertion of percutaneous catheter. (R)
10. We recommend the optimal position of the central catheter should be verified radiologically. (R)
11. Catheter dressings are changed regularly and as indicated. (D)
12. Educate patients and their families on the care of the percutaneous catheter. (D)

Rationale/Summary of Evidence

Rationale of Statement 1

Evidence showed that catheter-related bacteremia (CRB) is the most common complication for percutaneous catheters. For patients at high risk of device-associated and procedure-associated hospital-onset infections, strategies with an aim at prevention through reduction of alterable risk factor should be employed throughout the hospitalization period.[9,10]

Rationale of Statement 2

Percutaneous haemodialysis catheters serve as an important temporary vascular access during maturation of other permanent AV accesses, such as fistulae or grafts, or PD catheter is not ready for use.[11] However, the NKF KDOQI guidelines suggest that prevalent long-term or permanent CVC rates of less than 10% may be a realistic target.[12] Therefore, avoiding insertion of CVC or removal of unnecessary CVC in order to minimize the related complications is the most important statergy.[9,10]

Rationale of Statements 3, 5–8, 11

There are scanty published data on optimal nursing practices in the care of percutaneous haemodialysis catheters. Nevertheless, the catheters are used in life saving treaments.[13,14] Standard and safe nursing care during percutaneous catheters insertion is necessary in order to minimize the complications.

Rationale of Statement 4

The purpose of informed consent is to promote autonomy and transparency as well as helping patients to make an informed decision. Patients have the right to recognize the degree of their engagement, obligation and accountability throughout the informed consent.[15,16]

Rationale of Statements 9, 10

Appropriate insertion site selection and catheter tip position of the percutaneous catheters is important to minimize complications. The preferred insertion site is the right internal jugular vein, the position of the distal catheter tip should be at the junction of right atrium and superior vena cava estimated to be 5–6 cm below the right tracheobronchial angle on posterior-anterior projection.

The percutaneous haemodialysis catheters are associated with complications such as thrombosis, central vein stenosis and infection. Standardized and optimized nursing care is essential to minimize such complications. [9,12,14,17–20]

Rationale of Statement 12

Educate patient and family to prevent catheter-related infection including: [13,14]

- monitor vital signs including body temperature;
- keep insertion site dry and clean, no shower or swimming;
- stabilize the catheter and never remove the catheter cap;
- report if there is signs and symptoms of exit site infection;
- change dressings by trained personnel only.

Audit Items

1. Patient knowledge
2. HD catheter-related infection rate

2. CARE OF PATIENT FOR CREATION OF AV FISTULA OR AUTOLOGOUS/SYNTHETIC GRAFT

Introduction

A functioning and complication-free AV fistula is an ideal vascular access for haemodialysis patient. It associates with good clinical outcome in haemodialysis. Appropriate planning and effective renal nursing care will facilitate safe and timely creation of AV fistula or graft, minimize complications and optimize access survival. All these help to improve the treatment outcome.

Guideline Statements

1. We recommend implementation of standard precautions with transmission-based precautions in the care of patient for creation of AV fistula or AV graft. (R)
2. We recommend that informed consent is mandatory. (R)
3. Assess and evaluate the physical condition, past health history including severe coagulopathy, previous central venous catheter insertion and allergy history. (D)
4. Educate patients and their families on strengthening and preserving the veins including: (D)
   - regular hand-arm exercises, with or without a lightly applied tourniquet;
   - do not have routine blood work, intravenous catheter placement and peripheral insertion of central catheters into forearm veins;
   - preoperative mapping
5. Follow the unit guidelines for preoperative and post-operative care of the procedure. (D)
6. We recommend immediate and continuous assessment of the newly creation AVF/G. (R)
7. We suggest the provision of appropriate education to patients and their families on the post-operative care of AV fistula or AV graft creation including: (D)

   - monitor vital signs including blood pressure and body temperature;
   - maintain good personal hygiene habits;
   - keep all dressing dry and clean, observe signs and symptoms of AV fistula or AV graft infection;
   - check for the thrill over the AV access at least once a day;
   - elevate the arm with one pillow if swelling;
   - avoid constricting objects such as jewellery, tight clothing or tightly wrapped dressing on the access arm, and avoid resting heavy objects on the AV access;
   - avoid blood taking, blood pressure measurements or intravenous lines setting on the access arm;
   - report immediately if change in thrill, pain, fever, redness, swelling, bleeding, numbness, tingling, weakness, discoloration on the access arm;
   - continue normal daily activities; have regular hand-arm exercises once all stitches are removed and the wound has healed.

Rationale/Summary of Evidence

Rationale of Statement 1

In the process of care for patients at high risk for device-associated and procedure-associated hospital-onset infections, strategies with an aim at prevention through reduction of alterable risk factor should be employed throughout the hospitalization period.[10]

Rationale of Statement 2

The purpose of informed consent is to promote autonomy and transparency as well as help patients to make appropriate decision. Patients have the right to recognize the degree of their engagement, obligation and accountability throughout the informed consent especially in the risks, benefits and burdens of haemodialysis and vascular access placement. No concealment in a learning health-care system or any other health-care system.[16,21]

Rationale of Statements 3, 5

There are limited published data on the nursing practices for patients with AV access creation. However, patients requiring maintenance haemodialysis should ideally have a functioning permanent vascular access in place prior to initiating HD. Renal nurses have an important role in managing the new AV fistula or AV graft. Effective and safe nursing care will minimize the complications.

Rationale of Statement 4

The veins preserving education is to avoid loss of potential access sites in the arms and maximize the chances of successful fistula placement and maturation. Hand and arm isometric exercises with or without a lightly applied tourniquet will help in strengthening handgrip.[18,21–23]

The vessels-diagnostic mapping for ensuring the creation site of AV access may improve AVF patency. It guide and assess the feasibility of AV access placement, and determine the optimal location of AV access placement.[21,24–26]

Rationale of Statement 6

AV fistula, AV graft and tunnelled catheters are the choices of vascular access for chronic HD, the latter is the least optimal choice. Early referral, optimal AV access choice and vein preserving will help in establishing a functioning AV access for consistent haemodialysis.

Physical examination, clinical monitoring and assessment are the key in AV access maintenance. Renal nurses have to provide effective and safe nursing care to preserve the function of AV access by minimizing complications such as thrombosis, stenosis and infection.[18,21,26–28]

Rationale of Statement 7

Multidisciplinary team have to educate patients and their families on AV access care and prevention of complications. Surveillance and monitoring programs should be developed for early detection of signs of problems and risk of complications. [21,22,29]

Audit Items

1. Patient knowledge
2. Vascular access infection rate

3. CARE OF PATIENT ON HAEMODIALYSIS

Introduction

Haemodialysis is a common RRT offered in hospital based units, community haemodialysis centres, or as a self-care home modality. During the dialysis, the solute composition and the water content of a client's blood is altered via exposure of the blood to an electrolyte solution.[30] Removal of excess plasma water, uremic toxins, correction of electrolyte and acid-base imbalances can be accomplished in client with chronic renal failure or acute renal failure.[30]

Guideline Statements

1. We recommend all equipment used in the delivery and monitoring of the haemodialysis should comply with the relevant safety standards for medical electrical equipment and properly maintained throughout the recommended service life. (R)
2. We suggest the disposable items used in the delivery of haemodialysis, associated devices and extracorporeal circuits should comply with the requirements of the statutory medical device standards locally and internationally. (D)
3. We recommend the commercially produced concentrates for haemodialysis therapies, which are classified as medical devices, should meet the local and international standards. (R)
4. We recommend the water used in preparation of dialysis fluid should, as a minimum, meet the local requirements for chemical and microbiological contaminants. (R)
5. We recommend a standard operating procedure for sampling, monitoring and recording of feed and product water quality for haemodialysis should be established. (R)
6. We recommend obtaining informed consent before procedure. (R)
7. Provide appropriate education regarding to the reasons, procedure, treatment and its potential complications to patients and their families. (D)
8. We suggest assessing, appropriately intervening, monitoring, recording and reporting the patient's health status, vascular access and complications prior to, during and after the treatments. (D)
9. Confirm dialysis prescription and orders prior to initiating haemodialysis treatment. (D)
10. The procedure for cannulating AV fistulas and grafts or manipulating central venous catheter to connect or disconnect to the client's bloodstream should be performed under aseptic technique by qualified nephrologists or trained renal nurses. (D)
11. An access care and cannulation plan would be developed and documents. (D)
12. We suggest each unit should have policies and procedures for administration of catheter locking solutions to maintain catheter patency and keep systemic leak of the catheter lock solution to a minimum. (D)
13. We suggest blood sampling for biochemical and haematological measurements should be performed before haemodialysis using a dry fistula needle or syringe. (D)
14. We suggest adopting a standardized method in collecting post-dialysis blood sample. (D)
15. We recommend adequacy of dialysis or treatment outcomes should be monitored regularly. (R)
16. We recommend the infection control guidelines should be established for haemodialysis. (R)

Rationale/Summary of the Evidence

Rationale of Statements 1, 2 and 3

All equipment used in the delivery and monitoring of therapy should comply with the relevant standards for medical electrical equipment, the particular requirement for the safety of haemodialysis equipment and the general safety standards locally.[31–33] Machines should be properly maintained to ensure the quality delivery of treatments and duly replaced upon an assessment of the machine condition. The disposables items used in the delivery of haemodialysis, associated devices and extracorporeal circuits should signify the compliance with the requirements of the statutory medical device standards locally and internationally for patient safety.[31–33]

Rationale of Statement 4

The limits for chemical contaminants are adopted from the Association for the Advancement of Medical Instrumentation (ANSI/AAMI/ISO 23500:2011) by the Central Renal Committee (CRC), Hospital Authority while the microbiological contaminants are adopted from AAMI/ISO 13959:2009 by CRC.[34] The sample collection method should adhere to the infection control guidelines.[35]

Rationale of Statement 5

Monitoring and disinfection should be scheduled to prevent formation of biofilm rather than to eliminate it. A routine testing procedure for dialysate and feed water should be performed in the renal unit.[36] Testing for chemical contaminants will include continuous conductivity monitoring of the water leaving the reverse osmosis system, and regular in-house checks of hardness and total chlorine.[37] Records

should be kept of all chemical and microbiological test results and remedial actions.

Rationale of Statement 6

Patients have a fundamental legal and ethical right to decide what happens to their own bodies.[38] It respects persons' autonomy and right to make their choices and decision.[39] Valid consent for treatment is therefore absolutely central in all forms of health care from providing personal care to undertaking major surgery.[38]

Rationale of Statement 7

To gain better cooperation from client and family; to enhance patient's self-care and adherence to treatment.[40]

Rationale of Statement 8

Safe nursing care on patient with haemodialysis is crucial to minimize and early detection of complications.[40] Nurses should act promptly when emergency complications arise during haemodialysis treatment. These include hypotension and shock, disequilibrium syndrome, cramps, first use syndrome, cardiac events, suspected pyogenic reaction, air embolism, blood leak, clotting of dialyser and other mechanical failure.[41] Also, other vascular problems such as insufficient blood flow. Protocols and procedure guidelines for patient management should be available.[40,41] Safe haemodialysis should be provided to patient.

Rationale of Statement 9

To optimize the accuracy of HD treatment.[40]

Rationale of Statements 10 and 11

Arteriovenous access-related complications result in considerable morbidity. Haemodialysis procedures should be performed by a renal-trained staff.[42] Prevention of vascular access-related infection should be a high priority in the renal unit. All connections and disconnections should be performed under aseptic conditions by fully trained staff wearing a mask or visor and preferably with the patient wearing a surgical mask to decrease the risk of infection from nasal carriage of *Staphylococcus aureus.*[43]

Rationale of Statement 12

All catheter lock solutions should only be administered according to recommended dose and prescription. Otherwise, there is risk of threatening haemorrhage due to systemic anticoagulation from central venous dialysis catheter locks.[44] The policies and procedures plus staff training in the correct use of catheter locks containing anticoagulants to maintain catheter patency should be established.[45]

Rationale of Statement 13

Time-interval-related inter-dialytic and non-dialytic factors may influence pre-dialysis biochemical and haematological results.[46] The need for standardization of timing of pre-dialysis blood sampling in HD patients was important. All samples are taken using a dry needle or syringe to avoid dilutional sampling errors.

Rationale of Statement 14

Use of standardized methods of measuring dialysis dose of pre-dialysis and post-dialysis urea concentrations on dialysis session is to enable the comparison of treatment efficacy and adequacy assessment such as Kt/V modelling.[47]

Rationale of Statement 15

Regular monitoring of dialysis dose or treatment outcomes in haemodialysis patients should be performed to optimize the HD prescription and may enhance early detection of poorly functioning vascular access.[33]

Rationale of Statement 16

Chronic haemodialysis patients are at risk of infection for prolonged vascular access use.[48] In an environment where multiple patients receive dialysis concurrently, there is high opportunity for cross infection.[48]

Audit Items

1. Water quality for haemodialysis
2. Dialysis adequacy for patient
3. Vascular access infection rate

4. CARE OF PATIENT ON ON-LINE HAEMODIAFILTRATION

Introduction

On-line haemodiafiltration (on-HDF) is a form of RRT. On-line HDF aims to remove larger uremic toxins that conventional haemodialysis could not catered.[49,50]

Guideline Statements

1. We recommend that all equipment used in the delivery and monitoring of the on-line haemodialysis should comply with the relevant standards for medical electrical equipment and properly maintained throughout the recommended service life.[31–33,35] (R)

2. We suggest the disposables to be used such as dialyzers and associated devices, which are medical devices, should comply with the requirements of the statutory Medical Device standards locally and internationally.[33] (D)
3. We recommend the water used in preparation of dialysis fluid should at least meet the local requirements for chemical and microbiological contaminants.[31–33,35] (R)
4. We recommend a standard operating procedure is in place on the sampling, monitoring and recording of product water quality and on-line produced ultrapure replacement fluid be conducted at the recommended interval.[31–33,35] (R)
5. We suggest the preferred mode of vascular access for the on-line HDF should be in the order of preference as (i) AV fistula; (ii) AV graft; (iii) tunnelled central venous catheters and (iv) non-tunnelled central venous catheters, whenever applicable.[33,35,49,50] (D)
6. We recommend the implementation of standard precautions with transmission-based precautions in the care of patient receiving on-line HDF. (R)
7. We suggest a thorough checking of the quality of treated water for the on-line HDF, proper functioning of the machine and extracorporeal circuit as well as the vascular access.[35,49,50] (D)
8. We recommend the preparation of the machine and dialyser for on-line HDF; the putting on and taking off procedures and aftercare of the machine and consumables are performed by trained staff.[31–33,35] (R)
9. We suggest having an accurate implementation of the prescribed regimen according to the treatment plan. (D)
10. We suggest to assess, appropriately intervene, monitor, record and report the patient's health status or concerns prior to, during and after the treatment. (D)
11. We suggest an evaluation of the effectiveness and any complication of the treatment. (D)
12. We suggest the provision of appropriate education to the patient and family on the treatment to enhance the patient's self-care and adherence to the treatment. (D)
13. We recommend the adherence to the established corporate infection control guidelines.[33,35,49–53] (R)
14. We suggest having an accurate documentation of the process and the care delivered. (D)
15. We suggest the setting up of a standardized blood sampling protocol for haematological and biochemical measurements for adequacy assessment and regular monitoring of the larger uremic toxins such as β_2-microglobulin.[33,50–52] (D)

Rationale/Summary of Evidence

Rationale of Statement 1

All equipment used in the delivery and monitoring of therapy should comply with the relevant standards for medical electrical equipment, the particular requirement for the safety of haemodiafiltration and the general safety standards locally. Machines should be properly maintained to ensure the quality delivery of treatments and duly replaced upon an assessment of the machine condition.[31–33]

Rationale of Statements 3 and 4

The limits for chemical contaminants are adopted from the Association for the Advancement of Medical Instrumentation (ANSI/AAMI/ISO 23500:2011) by the CRC, Hospital Authority while the microbiological contaminants are adopted from AAMI/ISO 13959:2009 by CRC as well.[34,54,55] 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 the culture sensitivity. Endotoxin level should be less than 0.03 EU/mL and to be done monthly.[35] The sample collection method should also adhere to the corporate guidelines.[35]

Rationale of Statement 15

The purpose of HDF is to provide more large solute removal than haemodialysis. The EUDIAL group advised not to result in a reduction of small solute removal which should be at least the same as standard haemodialysis which is now quantified by form of Kt/V urea. A measure of serum β_2-microglobulin clearance or serum level would be a logical quantifier of the effect of HDF and the effective convection volume.

Limitations

1. The laws and regulation on HDF still varies among different countries. The development of a harmonized set of norms and regulations has been recommended by the EUDIAL group in 2012 to enhance quality control and improvements.[50–52]
2. The current ISO standard for replacement fluid used in HDF focuses on bacteria and endotoxin only. Other bioactive microbial contaminants, such as peptidoglycans and fragments of bacterial DNA were not discussed. The extent of these removal by the current on-line technique was unclear and may demand further attention through research.[55]

5. NOCTURNAL HOME HAEMODIALYSIS PATIENT TRAINING

Introduction

Nocturnal home haemodialysis (NHHD) is an effective home-based dialysis therapy for patient suffering from stage 5 CKD. The excellent long-term survival results reported by the Tassin group on patient dialyzed for 8 h three times a

week have been the yardstick of successful haemodialysis.[56] Patient or partner requires to undergo a comprehensive training program so as to acquire adequate knowledge and skills in mastering the haemodialysis-related equipment and be able to manage the emergency complications that may arise during the haemodialysis treatment. The training program aims to enable the patient to perform haemodialysis at home safely.

Guideline Statements

1. We recommend the NHHD Training Program be conducted in renal unit with NHHD service, with qualified nephrologists and renal nurses. (R)
2. We suggest selection criterions be established for recruiting patients into the NHHD training program. (D)
3. Functioning vascular access should be available before commencement of the NHHD teaching program. (D)
4. A designated nurse trainer for an individual patient is preferred. (D)
5. We suggest a well-structured training program should be in place. (D)
6. We recommend continuous assessment during the training period be conducted to ensure patient's competency in performing haemodialysis. (R)
7. We recommend infection control measures and precautions should be adhered when handling dialysis-related procedures. (R)
8. We recommend a monitoring system of home HD program including home visit should be established. (R)
9. We suggest 24-h consultation service is preferred. (D)
10. We suggest a back-up system should be available for patient receiving haemodialysis. (D)

Rationale/Summary of the Evidence

Rationale of Statements 1–4

Nocturnal home haemodialysis Training Program is conducted in renal unit with qualified nephrologists and nurses to provide training for patient so as to enable the patient to perform haemodialysis treatment at home safety. Nocturnal haemodialysis involved long haemodialysis for the duration of sleep alternate night or more frequently.[56–59] The safety issue is paramount important for the success of the home dialysis program.[59]

Rationale of Statement 5

Home haemodialysis training will be provided and patients will be trained in all aspects of dialysis. A competency package will be completed and signed off prior to transfer home.[57,60]

The teaching contents should include the following: (D)

- Basic knowledge of kidney disease and renal failure;
- Principles of haemodialysis and concept of NHHD treatment and the need of home therapy;
- Aseptic technique and comply with infection control guidelines;
- HD machine operations, also water treatment and dialyzer;
- Buttonhole technique or loop ladder technique should be taught according to vascular access condition;
- Patient should be taught to master special techniques if he/she is using PermCath or Gortex graft for vascular access;
- Priming dialyzer, initiating HD and trouble shooting of haemodialysis complications;
- Life-saving and home nocturnal haemodialysis safety issues such as use of fluid leak detector
- Taking off HD;
- After care of the HD machine and water treatment system and its maintenance;
- Proper methods on blood samplings and product water samplings.

Rationale of Statement 6

Nocturnal home haemodialysis training protocols and manual for nurses and patients should be available, assessment checklist and training records are maintained. Training various from 6 to 12 weeks depending on patient's learning ability and other factors such as vascular access problems. Training procedures on cannulation technique and psychological stress need to be addressed. Besides knowledge transfer of machines operation, trouble shooting and contingency management of dialysis-related complications are the crucial elements in NHHD patient training. A comprehensive NHHD training program includes all aspects of haemodialysis including blood taking. The use of fluid leak detectors are recommended as safety measures in NHHD.[57] Special technique in cannulation of buttonhole and graft will be taught.[61] Patient education and on-going assessment of the patient on NHHD training is recommended.[61]

Rationale of Statement 7

Proper use of disinfectant such as 2% chlorhexidine is recommended to prevent vascular access infection. Aseptic technique in cannulation or connection is important to prevent access infection or systemic infection.[35,62,63] Home haemodialysis machine, water treatment system and its maintenance are essential; monitoring of dialysis water quality is also required.[35]

Rationale of Statement 8

It is recommended that pre-training home visit for environmental assessment, and regular post-training home visits are essential in the NHHD program. There are hospital NHHD

policies on home visits and on-going assessment of the NHHD patient.[61,64]

Rationale of Statements 9, 10

Many home haemodialysis units provide 24-h consultation service.[56,60,61] NHHD back-up must be part of the support provided by dialysis unit.[56] It is suggested that health services should encourage home training and support systems, sustaining patients at home whenever possible.[58]

Outcome

Patients can perform haemodialysis at home safely after undergoing a comprehensive well-structured patient training program.

Audit Items

1. Patient's competency in performing haemodialysis on completion of NHHD training
2. NHHD patient vascular access infection rate
3. Nursing documentation on NHHD patient training

6. CARE OF PATIENT FOR INSERTION OF PERITONEAL CATHETER

Introduction

Peritoneal dialysis is an effective home-based dialysis therapy which is simple, convenient and relatively low cost for patient suffering from stage 5 CKD. The success of peritoneal dialysis hinges upon the patient possessing a functional peritoneal access.[41]

Guideline Statements

1. We suggest the patients requiring peritoneal catheter insertion will be able to undertake PD, and understand the principles of catheter care. (D)
2. Perform comprehensive preoperative assessment. (D)
3. We recommend that informed consent is mandatory. (R)
4. We recommend implementation of asepsis throughout the procedure. (R)
5. We recommend the patients should empty urinary bladder immediately before catheter insertion. (R)
6. We suggest the patients should have bowel preparation the day before surgery. (D)
7. We suggest the patients should bathe using antiseptic soap preoperatively. (D)
8. We suggest the patients should receive preoperative dose of prophlactic antibiotic. (D)
9. Discuss with patient for optimal exit site and mark it with indelible ink with patient sitting. (D)
10. Remove hair with electric clippers when necessary. (D)
11. Provide psychological support and counselling to patients and their families. (D)
12. Perform continuous post-operative assessment, monitor patency of PD catheter, proper wound and exit site care – keep intact. (D)

Rationale/Summary of Evidence

Rationale of Statements 1 and 11

In order to gain patient cooperation to the treatment plan, patient education topics should cover the knowledge and skills from the preparation phase to long-term care.[6,41,65–69] The topics should include:

1. Catheter and insertion site;
2. Insertion procedure;
3. Recovery phase;
4. Post-operative exit site care;
5. Potential complications;
6. Catheter break-in procedure.

Rationale of Statement 2

A comprehensive assessment for the patient is essential in developing and implementing of client-centred care plan.[69] The comprehensive assessment should include the following areas.

1. Patient/family ability and their support to perform PD and potential contraindications for PD, for example, extensive abdominal adhesions, irrepairable hernias;
2. Patient/family knowledge level and identified learning needs about peritoneal dialysis, develop and implement a plan including benefits and risks with peritoneal dialysis.

Rationale of Statement 3

The purpose of informed consent is to promote autonomy and transparency as well as helping patients to make an informed decision. Patients have the right to recognize the degree of their engagement, obligation and accountability throughout the informed consent.[16,70–72]

Rationale of Statement 4

The principle of aseptic technique should be complied during operation to prevent surgical site infection which accounts for 14%–16% of hospital-acquired infections.[73]

Rationale of Statements 5 and 6

Decrease the risk of intestinal perforation (0.5–3.5%) and bladder perforation during catheter insertion.[6,41,67,68]

Rationale of Statements 7 and 8

Decrease the risk of infection (7%) and peritonitis.[6,41,67,68]

Rationale of Statement 9

Discuss with patient on optimal exit site: avoid belt-line of trousers. The exit-site should be easily accessible for the patient to care for it. The exit-site should not be under an abdominal overhang in obese patient.[6,65–67]

Rationale of Statement 10

Remove hair only when it interferes with the operation to prevent surgical site infection.[41,67,73]

Rationale of Statement 12[6,41,67,69]

Although published data is limited, most frequent adopted nursing care strategies include:

1. Minimize potential complications by continuous monitoring, for example, bleeding, peri-catheter leak, pain and catheter patency;
2. Keep operative site clean to minimize bacterial colonization of exit site and tunnel, cover the operative site with an absorbent dressing;
3. Stabilize the catheter to minimize catheter movement and trauma.

Audit Item

Exit site infection

7. CARE OF PATIENT ON PERITONEAL DIALYSIS

Introduction

Peritoneal dialysis is one form of renal dialysis. It is a relatively simple and effective technique. It has been successfully developed as a major dialysis mode in Hong Kong. Peritoneal dialysis can be performed by manual connection or machine. The major responsibilities of renal nurse in PD care include deliver dialysis appropriately, prevent complications and monitor treatment effectiveness.

Guideline Statements

1. We recommend obtaining a valid informed consent before carry out peritoneal dialysis for patient. (R)
2. Monitor proper functioning of the peritoneal access. (D)
3. We recommend the application of non-touch aseptic technique during peritoneal dialysis exchange. (R)
4. Deliver PD treatment according to prescription and make adjustment if indicated. (D)
5. We suggest early detection of PD-related complications and deliver appropriate interventions accordingly. (D)
6. We recommend assessment of peritoneal function and adequacy of treatment regularly. (R)
7. We recommend implementation of standard precautions for disposal of the peritoneal dialysis effluent. (R)

Rationale/Summary of Evidence

Rationale of Statement 1

Informed consent is a part of quality care and it also implies a legal responsibility. Patients have the right to know all the information concerning the nature, potential risks and benefits, alternatives of the therapy or treatment they are going to receive before making decision to accept or not.[39,74]

Rationale of Statements 2–3

Peritonitis contributes to 16% deaths on PD. The commonest cause of PD-related peritonitis is intraluminal cause and it occurs because of the contamination of the connection sites and breaking of the transfer set or PD catheter.[75] Strictly adhere to non-touch aseptic technique in peritoneal exchange procedure is crucial to prevent peritonitis. In addition, protocol of contamination management should be in place to minimize the chance of peritonitis when contamination is occurred.[76] The routine of changing of transfer set every 6 months should be followed to prevent cracks and breaks from continuous use.

Rationale of Statement 4

The general principle of this statement is to achieve optimal treatment effect and adequacy of dialysis for individual patient.[77]

Rationale of Statement 5

Early detection of signs and symptoms of peritonitis will facilitate early empirical antibiotic treatment. Potentially serious consequences of peritonitis are more likely to occur if treatment is not provided promptly.[75,78] Exit site infection may lead to peritonitis and catheter removal. Keep exit site clean and dry, dress exit site and secure the dialysis catheter properly are the measures generally recommended to prevent exit site infection.[79] Antibiotic should be given according to the culture result of the infected exit site.[76,80] Inflow/outflow problem, fluid leaks, haemoperitoneum, hernia, PD-related pain are well-known non-infective complications which warrant close observation.[81,82]

Rationale of Statement 6

Scholars and previous guidelines stated that adequacy test and peritoneal equilibration test (PET) are essential to monitor the effectiveness of PD and guide the adjustment of PD regime.[77,83]

Rationale of Statement 7

Peritoneal dialysis effluent should be emptied to the drain and discard the empty bags into a garbage bag after it is properly clamped to prevent spill of body fluid to the envionment.[84]

Audit Items

Regular monitoring of PD adequacy.
Peritoneal equilibration test for all new patients.

8. CARE OF PATIENT WITH PERITONEAL DIALYSIS ACCESS

Introduction

In order to have effective PD, a good functioning PD access without complications is crucial for a PD patient. Complications such as exit site infection or tunnel infection are some of the major causes of morbidity and catheter lost. By performing standard renal nursing care and empowering patient self-care, renal nurses help to minimize complications and maintain a good functioning PD access.

Guideline Statements

1. We recommend daily assessment of exit site and catheter tunnel for signs of infection. (R)
2. Maintain the integrity and proper functioning of the PD catheter and transfer set. (D)
3. We suggest keeping exit site clean and dry. (D)
4. Have daily shower after exit site is completely healed. (D)
5. We recommend preforming the exit site dressing with aseptic technique if it is infected. (R)
6. We recommend securing the PD catheter properly. (R)
7. We recommend providing education to patient and care givers on daily care of PD catheter and exit site.[80] (R)

Rationale/Summary of Evidence

Rationale of Statement 1

Evidence showed that exit site infection can progress to peritonitis. Early detection of exit site and tunnel infection is essential for prompt treatment and prevention of peritonitis.[78,85]

Rationale of Statement 2

Damage of PD catheter or transfer set may induce peritonitis.[86] We should avoid using any sharp object near the PD catheter and transfer set. We should not kink the PD catheter and transfer set at any time. Change the transfer set regularly can prevent the damage due to wear and tear.

Rationale of Statements 3–4

Although evidence showed that there is no significant different between different kinds of dressing material in preventing exit site infection, but transparent occlusive dressing should not be used alone because it will allow moisture to accumulate at the exit site and increase infection risk.[87–89] Exit site should be kept dry before healed to prevent infection.[78,90]

Rationale of Statement 5

The aim of perform dressing with aseptic procedure is to minimize bacterial colonization of the exit site and tunnel.[90] Agent cytotoxic to mammalian cells should not be used at the exit site.[91]

Rationale of Statement 6

Exit site infection can be occurred as a consequence of exit site trauma. Minimize the chance of trauma by avoiding pulling or tension of the catheter is important to prevent exit site infection.[92]

Rationale Statement 7

Evidence showed continuous patient education is one of the factors to improve outcomes in exit site care.[80]

Audit Item

Exit site infection rate.

9. PERITONEAL DIALYSIS PATIENT TRAINING

Introduction

Peritoneal dialysis is a home-based RRT. Effective patient training program is an essential component of a successful PD program. International Society for Peritoneal Dialysis (ISPD) established the first set of ISPD recommendations for patient training in 2006.[93] Hong Kong has implemented Peritoneal Dialysis First Policy since 1985. Around 75% of the dialysis patients in Hong Kong are PD patients and are under the care of various PD centres. Peritoneal dialysis patient training guidelines/recommendations will guide PD

centres in the development of PD training program in the individual PD training centre.

Guideline Statements

1. Perform pre-dialysis assessment, including clients' (patients/family members) ability on handling and learning PD, prior to accepting a patient into the chronic PD program. (D)
2. Have a separate training area. (D)
3. Assign a designated PD nurse trainer for an individual patient. (D)
4. We suggest a well-structured PD patient training program based upon adult education principles and the latest ISPD Guidelines. (D)
5. Continue the training until the client acquire adequate knowledge and skills including:
   i. able to safely perform all the required procedures, (D)
   ii. able to recognize contamination and complications, (D)
   iii. able to follow the training recommendations. (D)
6. Include home visit as a part of the PD training program. (D)
7. Retrain the clients after peritonitis, catheter-related infection, prolonged hospitalization and any other interruption in PD. (D)

Rationale/Summary of Evidence

Rationale of Statements 1 to 3

There are very little published data on evaluating the effectiveness of PD training program. The limited clinical trials were unable to provide strong evidence to guide development of guidelines on PD patient training.

Rationale of Statement 4

There are suggestions on that structured PD training program with PD patient trainers possess of adult education knowledge will have benefit on patient outcomes.[93–100] The only large cohort study on PD patient training found that low training time (particularly <15 h), smaller centre size and the timing of training in relation to catheter implantation were associated with a higher incidence of peritonitis.[100]

Rationale of Statements 5 to 7

Ellis et al. noted a decline in peritonitis rates after implementation of a home visit program in a small group of patients.[101] Nevertheless, the evidence on the effects of home visits on patient outcomes was very limited. Currently, the 2006 ISPD recommendations on PD patient training provide guidance for both existing and new PD training programs.

Audit Items

1. Patient/helper PD technique
2. Patient/helper problem-solving knowledge
3. Peritonitis rate

10. PREOPERATIVE CARE OF PATIENT FOR RENAL TRANSPLANTATION

Introduction

Successful renal transplants offer the dialysis patients a full rehabilitation in all aspects of life.[102] All patients with CKD approaching or at stage 5 and who has no contraindications to kidney transplantation should be assessed for transplantation. The pre-transplant work up and assessment for all potential transplant candidates should begin as early as possible and this is a continuous process till date of operation. American Society of Transplantation also recommends that early intervention and evaluation could attain a positive outcome.[103]

In the preoperative phase, renal nurse plays a vital role to develop and implement the care plan; the ultimate goals are to ensure the patient receives safe and quality care before renal transplantation.

Guideline Statements

1. We recommend the ABO and HLA compatibility between donor and recipient must be ascertained before transplantation, or otherwise medical-related procedures have been arranged to overcome the ABO and HLA compatibility issues. (R)
2. We recommend the recipient should undergo a structured pre-transplant work up and continuous assessment to evaluate the physical and psychological fitness for transplantation.(R)
3. We recommend the recipient should receive all information about the kidney transplantation including the reasons, procedures, risks, pros and cons of kidney transplant as well as the care plan. Hence, a consent form must be signed. (R)
4. We suggest the recipient should receive all the preoperative preparations for kidney transplant according to transplant centre protocols. (D)

Suggestions of good practice

1. We should encourage patient to verbalize their feelings and allow them to ask questions. (D)

2. We suggested the pre-transplant preparation should include physical, psychological and educational support to the patient and family members. (D)
3. We suggest a multidisciplinary approach for the preoperative care of kidney transplant. (D)
4. The transplant nurse should develop a care plan with the patient and coordinates care delivery. (D)

Rationale of Guideline Statements

Rationale of Statement 1

In the past decade, desensitization therapies are introduced for kidney transplantation to overcome the ABO and antibodies incompatibilities. However, a substantial risk for antibody-mediated rejection was found in recipients with high titers and HLA-sensitized patients and that has impeded the long-term outcomes.[104]

Rationale of Statement 2

Physical and psychological evaluations are equally important to ensure that the recipient's pre-existing conditions will not be complicated by transplantation.[105,106] Early psychosocial evaluation and preparation of the potential recipient will enhance a better psychological adaptation for transplant, such claim is proven to attain a better transplant outcome.[107–109]

Rationale of Statement 3

This guideline addresses the importance of providing information to renal transplant recipient; the sharing should involve patient's family. The information will cover the reasons, risks of the operation including mortality, morbidity, side effects and risks of immunosuppression, surgical procedure and its complications. According to Patients' Charter in Hospital Authority, patient has the right to information, right to treatment and right to choices before they sign up a consent form for operation.[110]

Rationale of Statement 4

This is to ensure the patient is in optimal medical and psychological condition at the time for kidney transplantation.

Rationale for suggestions of best practice

The success of kidney transplantation begins with good preparation. Collaboration with multidisciplinary healthcare experts allows a comprehensive assessment of the patient's health status. Listening to patient's viewpoints and their needs facilitate a reciprocal interaction for an effective care delivery. Positive feedbacks from patients receiving preoperative teaching and information are evidence.[111]

Audit Item

Nursing documentation of the preoperative preparations

11. POSTOPERATIVE CARE OF PATIENT FOR RENAL TRANSPLANT

Introduction

Kidney transplant provides the best clinical outcomes for end-stage kidney disease patients in terms of morbidity, mortality and patient quality of life. With the advances in surgical technology, more understanding in infection control measures and the development in immunosuppressive medications, the clinical outcomes of kidney recipients have been further improved. Renal nurses are one of the important care providers for kidney recipients. It is important to provide safe and effective nursing care for kidney recipients post kidney transplant in order to minimize the avoidable complications and achieve optimal clinical outcomes.

Guideline Statements

1. We recommend implementation of standard precautions with transmission-based precautions in the care of kidney recipients. (R)
2. We suggest close monitoring on the fluid status, wound and drains, and vital signs of the kidney recipients, with urine volume measurement every 1-2 h for at least 24 h, immediate post-operation. (D)
3. Administer prescribed medications with monitoring on the effects and side effects of the medications. (D)
4. Provide psychological support and counselling to kidney recipients and their families. (D)
5. Educate kidney recipients and family members regarding:
   - preventive measures, warning signs, daily monitoring strategies and handling procedures for the potential complications, (D)
   - indications, potential side effects, special issues, daily monitoring strategies and the prescribed regimen of immunosuppressive medications, (D)
   - healthy lifestyle including stop tobacco use, and reduce weight as needed. (D)
6. Counsel kidney recipients and their partners about fertility, pregnancy and uses of immunosuppressant in relate to pregnancy. (D)

Rationale/Summary of Evidence

Rationale of Statement 1

In the process of care for patients at high risk for device-associated and procedure-associated hospital-onset infections, strategies with an aim at prevention through reduction of alterable risk factors should be employed throughout the hospitalization period.[10,112]

Rationale of Statement 2

Rejection and infection are common and serious complications of transplant recipients. Previous clinical practice guidelines have been suggesting monitoring of urine output every 1 to 2 h at least in the first 24 h post-kidney transplant.[113]

Rationale of Statements 3–6

Non-adherence has been found to be associated with a high risk of acute rejection and allograft loss.[114–117] Improving patient treatment adherence would be one of the possible ways to improve the clinical outcomes in kidney recipients.

There are very little published data on evaluating the daily nursing practices for kidney recipients. The established nursing practices on care of kidney recipients usually include both physical and psychological care. A bundle of care including monitoring on the effectiveness of treatments; empowering patients through counselling and education; promoting treatment adherence by enhancing patient knowledge are the usual nursing strategies for transplant recipients from acute post-operative stage to long-term rehabilitation.

Audit Items

1. The nosocomial infection rate
2. Patients' knowledge level
3. Nursing documentation on patient assessment

12. CARE OF PATIENT ON CHARCOAL PERFUSION (CHARCOAL HAEMOPERFUSION)

Introduction

Haemoperfusion is a process whereby blood is passed through a device containing adsorbent particles. Haemoperfusion will remove many lipid-soluble drugs from the blood more efficient than haemodialysis but the technique is less widely available.[6,41] Sorbent haemoperfusion systems are used in the treatment of poisoning, drug overdose, hepatic coma or metabolic disturbances.[118]

Guideline Statements

1. Perform comprehensive pre-procedure assessment. (D)
2. We recommend that informed consent is mandatory. (R)
3. We suggest the patient to have a functional vascular access for haemoperfusion. (D)
4. We suggest priming of the haemoperfusion device and circuit of the cartridge according to the manufacturer recommendation. (D)
5. Ensure aseptic technique in handling the accessories for charcoal perfusion. (D)
6. Ensure adequate haeparinization and monitor clotting profile during the treatment. (D)
7. Close monitoring of patient during the treatment. (D)
8. Provide education regarding to the reasons, procedure and its potential complications to patients and their families. (D)

Rationales

Rationale of Statement 1

There are little published data on pre-procedure assessment as haemoperfusion is rarely performed nowadays. The nurses should assess patient's conscious level, vital signs, drugs level, clotting factors and complete blood picture. Thrombocytopenia is one of the complications of haemoperfusion.[6,41]

Rationale of Statement 2

The purpose of informed consent is to promote autonomy and transparency as well as helping patients to make an informed decision. Patients have the right to recognize the degree of their engagement, obligation and accountability throughout the informed consent.[16,70–72]

Rationale of Statement 3

If AV fistula or a synthetic graft is not available for the procedure, central venous catheter or other vascular access can be considered.[41,119]

Rationale of Statement 4

Some cartridge requires priming with a dextrose solution to prevent subsequent hypoglycaemia.[6,41]

Rationale of Statement 5

Prevent catheter related blood stream infection is essential in all patients with a central catheter.[41]

Rationale of Statement 6

Some heparin is adsorbed by charcoal.[6,41]

Rationale of Statement 7

Detect complications and take appropriate actions accordingly:

Detect for hypotension, itching and rash, mild transient thrombocytopenia and leucopenia, prolonged anticoagulation may predispose to bleeding etc. All the complications require early intervention.[41,118,119]

Rationale of Statement 8

Effective client communication can gain cooperation from the patient and the family.

Audit Item

The nosocomial infection rate, for example, catheter-related blood stream infection.

13. CARE OF PATIENT ON TPE

Introduction

Therapeutic plasma exchange also known as plasmapheresis is a process used to filter toxic substances out of a patient's blood plasma. Therapeutic plasma exchange is used in the treatment of a variety of kidney diseases and other conditions of the immune system. The blood is drawn and channelled through a machine that separates out the plasma and replaces it with a plasma substitute. The treated blood is then pumped back into the patient's bloodstream.[120]

Guideline Statements

1. We recommend informed consent should be obtained by trained staff prior to TPE. (R)
2. Provide appropriate education regarding to the reasons, procedure, treatment and its potential complications to patients and their families. (D)
3. Psychological support would be provided for patient undergoing TPE. (D)
4. We recommend all equipment used in the delivery and monitoring of the TPE should comply with the relevant safety standards for medical electrical equipment and properly maintained throughout the recommended service life. (R)
5. We suggest the disposable items used in the delivery of TPE, associated devices and extracorporeal circuits should comply with the requirements of the statutory medical device standards locally and internationally. (D)
6. We recommend the TPE should be performed by a trained health-care professional and with availability of resuscitation facilities. (R)
7. The procedure for connecting or disconnecting from the client's vascular access to bloodstream should be performed under aseptic technique by trained health-care professional. (D)
8. We suggest the guideline on vascular access care for TPE should be developed and documented. (D)
9. Confirm TPE prescription and orders prior to initiating treatment. (D)
10. We recommend assessing, appropriately intervening, monitoring, recording and reporting the patient's health status, laboratory results, vascular access and complications prior to, during and after the treatments. (R)
11. We suggest the clinical outcome of a course of procedures should be documented. (D)
12. We suggest angiotensin-converting-enzyme (ACE) inhibitor drugs should be avoided before TPE procedure. (D)
13. We suggest monitoring of anticoagulation for TPE should be documented. (D)
14. We recommend the guidelines for TPE should be established. (R)
15. We recommend the infection control guideline for TPE should be established. (R)

Rationale/Summary of the Evidence

Rationale of Statement 1

Patients have a fundamental legal and ethical right to decide what happens to their own bodies.[38] It respects persons' autonomy and right to make their choices and decision.[39] Valid consent to treatment is therefore absolutely central in all forms of health care from providing personal care to undertaking major surgery.[38]

Rationale of Statements 2 and 3

To gain better cooperation from client and family and adherence to the treatment.[121]

Rationale of Statements 4 and 5

Ensure the equipment and associated devices used in the delivery of TPE should comply with the relevant standards locally or internationally for patient safety.[33,122] Machines should be properly maintained to ensure the quality delivery of treatments and duly replaced upon an assessment of the machine condition.[33,122]

Rationale of Statement 6

Therapeutic plasma exchange procedures involve certain risks to patients.[123] Trained staff in operation of the procedures can assure patient's safety and the delivery of appropriate care.[122]

Rationale of Statements 7 and 8

Prevention of vascular access-related infection should be a high priority. With a trained staff can develop and maintain skills that should lead to better patient care and reduce the risk of complications.[124] All connections and disconnections should be performed under aseptic conditions by fully trained staff wearing a mask or visor and preferably with

the patient wearing a surgical mask to decrease the risk of infection from nasal carriage of *Staphylococcus aureus*.[125]

Rationale of Statement 9

To optimize the accuracy of TPE treatment.[126]

Rationale of Statement 10

Safe nursing care on patient with TPE is crucial to minimize and early detection of complications.[126]

Rationale of Statement 11

The clinical outcome of TPE should be documented for clinical efficacy.[122]

Rationale of Statement 12

Angiotensin-converting-enzyme inhibitor drugs increase the risk of vasovagal problems for all TPE procedures.[122]

Rationale of Statement 13

Anticoagulation of blood in the extracorporeal circuit is required to prevent the filter and circuit from clotting. Ensuring catheter patency for adequate flow rates will minimize the risk of build-up of fibrin.[127] Citrate-induced hypocalcaemia is a common side effect of TPE if citrate is used as anticoagulant.[122]

Rationale of Statement 14

The guidelines for TPE should be established to achieve uniformity of the performance, to minimize operational errors, clinical hazards associated with the procedures and the avoidance of complications.[123]

Rationale of Statement 15

In an environment where repeated opportunities for person-to-person transmission of infectious agents, directly or indirectly via contaminated devices, equipment and supplies, environmental surfaces or hands of personnel would increase risk of infection.[48] Preventing transmission of blood borne viruses and mix up of therapy products could reduce the risk of getting infection and complication.[48,126]

Audit Items

Vascular access infection rate

14. NURSING ROLE IN INFECTION CONTROL IN RENAL DIALYSIS UNITS

Introduction

It is prudent to provide a safe environment in renal units to protect both patients and staff from exposure to various pathogens and ensure safe delivery of renal replacement therapies and patient care activities. Renal units, being in a health-care setting, no matter in the hospital or as an ambulatory care, are at risks of the transmission of infectious agents. The increased opportunities of exposure to blood and body fluid spillage during dialysis predisposed them towards blood borne infections, in particular nosocomial cross-infections among patients and staff. Renal patients are often regarded as immunocompromised host due to the kidney failure and the dietary restrictions, or as a result of the immunosuppression after kidney transplant, may have serious consequence upon an infection. The recent upsurge of emerging infections such as multiresistant organisms has rendered the situation more complex. Therefore, infection control and surveillance aim to prevent infections among staff members and patients in the renal units.

The key theme of this guideline will focus on (i) general recommendation on components in the renal unit; (ii) standard precautions for preventing transmission during patient care practices and the implementation of transmission-based precautions for the pathogens and the ways that mediate the infections; (iii) renal-specific infection control practices. Besides, the implementation of respiratory hygiene/cough etiquette evolved after the SARS epidemic and preventive measures to offer engineering and design interventions in decreasing environmental bugs for the severely immunocompromised host among our post-kidney transplant patients are also included.

The transmissions of pathogens within a health-care setting require three elements: a source (or reservoir) of pathogens, a susceptible host and a portal of entry, receptive to the pathogen, and a mode of transmission. The pathogens may come from patients, health-care staff, household members and visitor or inanimate environmental sources. The immune state of the host at the time of exposure, interaction between pathogens and virulence of the agent also affects the overall outcome. Host factors such as extremes of age and underlying disease like diabetes, HIV/AIDS; malignancy and transplants can increase susceptibility to infection may have adverse outcome. Surgical procedures, radiation therapy, immunomodulation, indwelling devices or implants may facilitate hospital-acquired infections.[128] These are to be addressed in the daily practice of the renal unit also.

Guideline Statements

1. We suggest the design and engineering of the renal unit shall take into account the size of the service loads and

types of patients to ensure adequate spacing, lighting, layout, staff duty assignment and working environment, cohort and isolation needs and avoid overcrowding; and facilities to implement transmission-based precaution so that patients and staff activities can be well accommodated as well as the transport of consumables and waste to and from the unit. (D)

2. We recommend the renal unit should have in place the operation of the water treatment systems, monitoring and maintenance schematics; the operation and disinfection of haemodialysis machines; routine and urgent repair schemes and facilities; infection control; waste disposal, risk management and contingency plan on major service interruption.[31,32,35] (R)
3. We recommend that all equipment used in the delivery and monitoring of the various dialysis therapies should comply with the relevant standards for medical electrical equipment and properly maintained throughout the recommended service life.[31–33,35] (R)
4. We recommend the disposables to be used such as dialyzers and associated devices, which are medical devices, should comply with the requirements of the statutory medical device standards locally and internationally.[33] (R)
5. We recommend the water used in preparation of dialysis fluid should, as a minimum, meet the local requirements for chemical and microbiological contaminants.[31–34,53–55] (R)
6. We suggest the ready-made concentrates for the haemodialysis treatment, which are classified as medical devices, should meet the local and international standards and are properly stored and consumed according to the recommended shelf life, verified for package integrity and used within expiry date.[35] (D)
7. We recommend the renal unit should have in place an operation procedures and guidelines on the nursing practice, dialysis-related procedures, handling blood and body fluid spillages.[31,32,53](R)
8. We recommend a standard operating procedure on the sampling, monitoring and recording of product water quality for preparing dialysate is in place and according to the recommended safety limits and conduct at the recommended interval with corrective actions are applied as indicated from the results.[31–35,53–55] (R)
9. We suggest all haemodialysis machines are disinfected after use and repairs, exceeded the recommended time of last disinfection and a testing of the potency and residual chemicals if chemical disinfection is employed during the disinfection.[35,53] (D)
10. We recommend the cleaning of the surfaces of the dialysis machines with an appropriate topical disinfectant after each session.
11. We suggest that patients undergoing renal replacement therapies must be under the care of qualified renal nurses with infection control as a core component of training.[31,32,53] (D)
12. We suggest that all technical staffs or dialysis assistants should be formally trained with infection control as a core component of training and work under the supervision of qualified renal nurses.[32] (D)
13. We suggest no reuse of dialyzers, bloodlines or other single use devices.[33,35,53] (D)
14. We recommend the surveillance of patient's status of blood borne virus as well as multiresistant organisms as the corporate guidelines prior to the first haemodialysis treatment according to the corporate guidelines on infection control of nephrology services and make necessary spatial isolation and segregation of machines and clinical care equipment. Regular retesting should also be conducted as recommended.[31,32,35] (R)
15. We recommend vaccination of susceptible staffs and patients to HBV infection.[32,35] (R)
16. We recommend the application of protocol in rectifying the carrier state of certain multiresistant organism such as MRSA if evidence of the clinical efficacy is available to prevent the infection.[35] (R)
17. We suggest the preferred mode of vascular access for the convective-based therapies should be in the order of preference as (i) AV fistula; (ii) AV graft; (iii) tunnelled central venous catheters and (iv) non-tunnelled central venous catheters, whenever applicable.[31–33,35] (D)
18. We suggest a thorough checking of the quality of treated water daily, ensure proper functioning of the machine and dialysis circuit as well as the vascular access prior to the initiation of haemodialysis treatment.[35,53] (D)
19. We suggest to thoroughly assess, appropriately intervene; monitor, record and report the patient's health status, especially infective foci prior to, during and after the dialysis treatments or renal replacement therapies.[31–33,35,53] (D)
20. We suggest the provision of appropriate education to the patient and family on the treatment and prevention of infection to enhance the patient's self-care and adherence to the treatment.[53](D)
21. We suggest the guidelines on cleaning and disinfections, linen, waste and sharps disposal are in force at all times.[35,53] (D)
22. We recommend the appropriate use of personal protective equipment to limit the transmission risk.[35,53] (R)

DISCLOSURE

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NEPHROLOGY

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Supplement Article

Clinical practice guidelines for the provision of renal service in Hong Kong: Infection Control in Renal Service

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A GENERAL INFECTION CONTROL MEASURES IN RENAL UNITS

A1 Design of the renal unit

The increased risk of exposure to blood, body fluids and other potentially infectious materials during dialysis procedures and the immunocompromised state of the patients with end-stage kidney disease are unique features of the Renal Units which predispose to nosocomial infections, especially blood borne infections, among patients and staff. The design of the Renal Units should take such infection risks into consideration and facilitate the implementation of a high level of infection control measures to minimize the risk of nosocomial infections in the Renal Units.

Guideline statements

1. There should be adequate operating space in the Renal Units, between beds and haemodialysis (HD) stations for staff to safely carry out their clinical duties.[1] [D]

2. The lighting, temperature and noise levels of the Renal Units should be optimized to provide a comfortable working environment for staff.[1] [D]
3. There should be designated single-patient rooms or cubicles in the Renal Units to isolate patients with potentially infectious diseases. [R]
4. There should be designated patient rooms or cubicles in the Renal Units to cohort patients infected with the same strain of multidrug-resistant microorganisms. [D]
5. There should be designated clean areas in the Renal Units for the preparation, handling and storage of medications, equipment and supplies.[2] [R]
6. There should be designated areas in the Renal Units for handling or storing contaminated or used supplies and equipment, which are separated from areas where medications, clean equipment and supplies are handled or stored.[2] [R]
7. There should be designated areas, which are separated from the clinical areas, for staff to eat and drink.[3] [R]
8. There should be adequate hand hygiene facilities such as hand wash basins or alcohol-based hand rub dispensers in the Renal Units, which are easily accessible to staff, patients and visitors. [R]
9. There should be adequate supplies of personal protective equipment in the Renal Units, which are readily available at the point of use. [R]
10. There should be dedicated HD machines for patients who are hepatitis B virus (HBV) infected.[4] [R]
11. There should be designated segregation areas for HBV-infected patients to undergo HD.[4] [R]

A2 Hand hygiene

Hand hygiene refers to either hand washing with soap and water or application of an alcohol-based hand rub. It has been well documented that contaminated hands of health-care workers play an important role in the transmission of health-care-associated infections.[5] Hand hygiene is regarded as the most important measure in reducing the transmission of health-care-associated infections in the health-care settings. Adherence to proper hand hygiene practice is of paramount importance in preventing cross infection in the Renal Units.

Guideline statements

1. Staff working in Renal Units should cover cuts or abrasions on their bodies, especially the exposed parts, with waterproof dressings.[6] [R]
2. Staff must perform hand hygiene (i) before touching a patient; (ii) before a procedure; (iii) after a procedure or exposure to body fluids; (iv) after touching a patient and (v) after touching a patient's surroundings.[7] [R]
3. When the hands are visibly dirty or visibly soiled with blood or other body fluids, the hands should be washed with soap and water and dried thoroughly with paper towel.[7] [R]
4. When the hands are not visibly soiled, routine hand hygiene can be carried out with alcohol-based hand rubs.[7] [R]
5. Hand hygiene facilities should be near the site of patient care such as the HD station.[8] [R]
6. There should be adequate number of hand wash basins in the Renal Units to allow easy access for the staff to perform hand hygiene.[8] [R]
7. There should be at least one hand wash basin in each segregation area of dialysis.[1] [R]
8. Alcohol-based hand rub should be made readily available in the Renal Units and be placed at the point of patient care such as next to each HD station or at the end of each patient's bed. [R]
9. All patients and visitors should carry out hand hygiene on entering and leaving the Renal Units.[9] [R]
10. All patients should clean their hands with alcohol-based hand rub before taking meals and medications, and practice hand hygiene after using bedpan, urinal and attending toilet. [R]

A3 Personal protective equipment

The clothing and body parts of staff working in the Renal Units may become contaminated with blood, body fluids, multiresistant microorganisms or other potentially infectious materials during patient care practices. Such contaminations may serve as a source of cross infection among staff and patients. Personal protective equipment refers to specialized clothing or equipment such as gloves, protective gowns, aprons, masks, goggles and face shields worn by a health-care worker that serve to prevent them from getting in touch with infectious materials. Appropriate use of personal protective equipment will help to protect the staff from acquiring infections and minimize the risk of cross infection between patients.

Guideline statements

1. There should be sufficient supplies of personal protective equipment, which are of different sizes to suit the needs of staff, in the Renal Units and at the point of patient care. [R]
2. Staff should wear personal protective equipment including gloves, protective gowns, aprons, masks, goggles and face shields appropriate to the nature of the procedure being performed whenever there is a likelihood of exposure to blood, body fluids and other infectious materials.[1] [R]
3. Staff should change gloves and aprons and perform hand hygiene between caring for different patients and working at different HD stations.[6] [R]

4. Staff should change gloves and aprons and perform hand hygiene between different procedures for the same patient.[6] [R]
5. Staff should change their personal protective equipment as soon as feasible when it becomes contaminated with blood or body fluids.[6] [R]
6. Staff should remove personal protective equipment including gloves, apron and/or gowns and perform hand hygiene after performing a procedure or on leaving the clinical work area. [R]
7. Staff should dispose used or contaminated personal protective equipment in proper waste containers. [R]

A4 Medication safety

Outbreaks of blood borne infections have been reported among HD patients because of improper preparation, handling and administration of parental medications.[10] Examples of unsafe practices that contribute to these outbreaks include contamination of the medication vials with patients' blood or body fluids and reuse of syringe in the administration of the medications between patients. Careful attention to medication safety helps to minimize the risk of inadvertent transmission of infection to patients through the parental routes.

Guideline statements

1. Staff should carry out hand hygiene before and after handling medications. [R]
2. All parental medications should be prepared using aseptic techniques in a designated clean area in the Renal Unit away from the HD stations.[8] [R]
3. Single-use or single-dose medication vials should be used whenever possible. [D]
4. If multiple-dose medication vials have to be used, each vial should be used on a single patient only and should be clearly labelled with the patient's name and for use by that patient only.[1] [D]
5. Multiple-use of bottles or bags of intravenous (IV) fluids should be avoided as far as possible. [D]
6. A new sterile syringe and needle should be used each time medication is aspirated from the medication vial. [R]
7. Single-dose IV fluid containers should be used for IV flush purposes. [D]
8. Medications delivered to the patient's dialysis station should be used for that patient only and should not be used on another patient. Unused medications should be discarded.[6] [R]
9. Trays used to deliver medications to individual patients must be cleaned between uses for different patients.[6] [R]
10. Common medication carts or trolleys should not be used to deliver medications to patients.[6] [R]

A5 Cleaning and disinfection of the environment

The environmental surfaces of the Renal Units such as the floor, dialysis chairs, countertops and the exterior surfaces of HD machines could easily become contaminated with patients' blood or body fluids, making them a potential source of nosocomial infections. Regular cleaning and disinfection of these surfaces will minimize the risk of transmission of infections in the Renal Units.

Guideline statements

1. Supporting staff allocated to work in the Renal Units should receive appropriate training in infection control.[11] [R]
2. Supporting staff should wear appropriate personal protective equipment while carrying out routine cleaning of the Renal Units. [R]
3. The environmental surfaces of the Renal Units and the exterior surfaces of medical equipment should be cleaned and disinfected regularly (at least daily) using 1:99 household bleach (1 part 5.25% sodium hypochlorite solution in 99 parts water) or other equivalent disinfectants.[11] [R]
4. The environmental surfaces of the Renal Units and the exterior surfaces of medical equipment should be cleaned and disinfected using 1:49, 1000 ppm of sodium hypochlorite solution if clostridium difficile or norovirus infection is suspected. [R]
5. The environmental surfaces of the Renal Units should be cleaned and disinfected when they become visibly soiled or after contamination.[8] [R]

A6 Cleaning and disinfection of medical instruments and equipment

Guideline statements

1. Frequently used medical equipment such as tourniquets, blood pressure cuffs and clamps should be designated to each patient. [D]
2. The touched surfaces of reusable medical equipment should be cleaned with detergent and water between patient uses.[12] [D]
3. Equipment that are used at a patient's dialysis station should be dedicated for use by that patient only or thoroughly disinfected prior to return to a clean area for use by another patient.[6] [R]
4. Disposable patient-care items (e.g. blood pressure cuffs) should be used whenever possible when the patient is potentially infectious or when contact precautions are warranted.[8] [D]
5. Non-disposable items that cannot be cleaned and disinfected thoroughly (e.g. cloth-covered blood pressure

cuffs) should be dedicated for use on a single patient.[8] [R]
6. The external surfaces of the dialysis machine should be cleaned with detergent and hot water and dried thoroughly after each patient use in accordance with the manufacturer's instructions, [R]

A7 Sharps disposal

Sharps used in the Renal Units such as dialysis needles may be contaminated with patients' blood or body fluids. Accidental injury of staff working in the Renal Units by used sharps poses a risk of transmission of blood borne infections from patients to staff.

Guideline statements

1. Staff should exercise caution when handling sharps in the Renal Units, especially when they are contaminated with blood or other body fluids, to avoid accidental injuries. [R]
2. Sharp boxes should be made readily available in the Renal Units and should be located as close as possible to the point of use. [R]
3. Staff who has used sharps when carrying out clinical procedures in the Renal Units should be responsible for the prompt and safe disposal of the sharps.[12] [D]
4. Staff must not recap or re-sheath used sharps such as dialysis needles.[1] [R]
5. All sharps should be discarded into an approved sharp box at the point of use. [R]
6. Sharps boxes should be large enough to contain the types of sharp devices that are being used in the Renal Units.[6] [R]
7. Sharps boxes should not be filled with used sharps to more than three quarter full. [R]
8. Sharps containers should be properly sealed and labelled, before being transported to their safe disposal in accordance to code of practice for the management of clinical waste.[13] [R]

A8 Waste management

Substantial amount of clinical waste is generated in the Renal Units during their daily operation. Clinical waste from Renal Units includes any waste contaminated with blood or body fluids or other potentially infectious materials, used peritoneal and HD fluids. Clinical waste should be regarded as potentially infectious and be handled with care to avoid contamination of the environment.

Guideline statements

1. All clinical waste generated from the Renal Units should be placed in specific color-coded containers, properly sealed, packaged and stored temporarily as required.[13] [R]
2. All clinical waste should be collected by licensed clinical waste collectors for its safe disposal in accordance to code of practice for the management of clinical waste.[13] [R]
3. Used peritoneal dialysis (PD) fluids should be disposed of directly to the drain or by pouring carefully into a sluice. [R]
4. Used HD fluids should be disposed of directly to the drain. [R]

A9 Management of blood and body fluid spillage

Spillages of blood, body fluids or other potentially infectious materials may lead to the dissemination of infectious agents within the Renal Unit and should be dealt with promptly.

Guideline statements

1. Staff should be trained in the proper disinfection procedures involved in the handling of spillages of blood and other body fluids. [R]
2. Staff should wear appropriate personal protective equipment when dealing with spillages of blood and other body fluids. [R]
3. For spillage of blood and other potentially infectious substances, the visible matter should be cleaned with disposable absorbent material. [R]
4. The spillage area should be mopped with a cloth or paper towels wetted with one part of house hold bleach (5.25% hypochlorite solution) in four parts of water, and left for 10 min. The area should then be rinsed with water.[11] [R]
5. Small spill of blood can also be removed by applying chlorine-releasing granules or powder directly to the spill, which can then be removed using paper towels or wipes.[11] [D].
6. For spillage of other body fluids such as vomitus or spent peritoneal dialysate, the visible matter should be cleaned with disposable absorbent material. [R]
7. The spillage area should be mopped with a cloth or paper towels with 1 part of household bleach (5.25% hypochlorite solution) in 49 parts of water, and left for 15–30 min. The area should then be rinsed with water.[11] [R]
8. Staff should remove the personal protective equipment and perform hand hygiene after handling the spillage of blood or other body fluids. [R]

A10 Staff training

Guideline statements

1. Staff working in the Renal Units including medical, nursing and supporting staff should receive training in

infection control practices, especially proper hand hygiene techniques and appropriate use of personal protective equipment. [R]
2. All health-care workers should attend infection control refresher training course once every 24 months. [R]

A11 Surveillance and audit

Surveillance of dialysis-related infections in the Renal Units involves systemic collection, analysis and interpretation of data concerning infection-associated events which helps to identify trends and develop improvement measures to reduce infection-associated mortality and morbidity.

Guideline statements

1. Each Renal Unit should develop a surveillance program to monitor, review and evaluate the serological status of its patients for blood borne virus, microbiological screening for multidrug-resistant microorganisms and the quality of water for HD. [R]
2. Each Renal Unit should regularly audit the compliance of its staff to infection control practices such as hand hygiene. [D]

B INFECTION CONTROL MEASURES OF THE DIALYSIS FACILITY/DIALYSIS EQUIPMENT

Haemodialysis patients are exposed to a large volume of water (typically 120–150 L) during each HD treatment session. Bacterial proliferation and bacterial biofilm formation might occur on the inner surfaces of the water distribution piping. Contamination of the water used for HD with bacteria and endotoxins produced by the bacteria might lead to the development of pyrogenic reactions (fever, hypotension, nausea vomiting) in the patients undergoing HD. Proper treatment of the water used for HD and regular disinfection of the water distribution system in the HD unit is essential to keep microbiological contamination of the water used for the preparation of dialysis fluid for HD below acceptable limits.

B1 Water quality

Guideline statements

1. The quality of water used for HD should be tested regularly to confirm the proper functioning of the water treatment system and to ensure that the water quality meets the required standards of purity for HD. [R]
2. The total viable microbial count and the endotoxin concentration in the dialysis water used for routine HD should be less than 100 CFU/mL and less than 0.25 IU/mL, respectively.[14] [R]
3. The total viable microbial count and the endotoxin concentration in the dialysis water used for on-line haemodiafiltration should be less than 0.1 CFU/mL and less than 0.03 IU/mL, respectively.[14] [R]
4. If the total viable microbial count of the dialysis water is more than 50 CFU/mL but less than 100 CFU/mL, corrective measures such as disinfection of the water treatment system and retesting the water quality should be undertaken.[15] [R]
5. The Renal Units should have standard operating procedures in place to regularly sample, monitor and record the quality of dialysis water and dialysis fluid.[15] [R]
6. The total viable microbial count and endotoxin levels should be measured at different points along the water distribution system and at different dialysis stations. [R]
7. The total viable microbial count and endotoxin concentration of the reverse osmosis water and dialysate should be monitored at least once a month.[16] [R]
8. Endotoxin levels in the dialysis water and dialysis fluid should be measured regularly using appropriate method such as the limulus amoebocyte lysate (LAL) test or other equivalent methods.[16] [D]
9. Appropriate culturing method, culture media and incubation parameters, such as incubation on Tryptone Glucose Extract Agar at 20–22 °C, should be used to culture bacteria from the dialysis water and dialysis fluid.[16] [D]
10. Water samples collected from the water distribution system or the dialysis machines should be assayed within 30 min after collection or be stored at 4 °C and assayed within 24 h.[17] [R]

B2 Disinfection of the water treatment/distribution system and HD machines

Guideline statements

1. The water treatment system and the water distribution system should be designed in such a way as to ensure smooth flow of water through the system which will minimize the formation of bacterial biofilms and allow routine disinfection of the system.[18] [R]
2. The water treatment system, water distribution system and HD machines should be disinfected regularly by either internal heat sterilization or chemical sterilization or a combination of both methods in accordance to the manufacturer's recommendations. [R]
3. If chemical sterilization is used, appropriate measures should be in place to test for the residual levels of the chemical disinfectants in the dialysis machines. [R]

C PREVENTION OF DIALYSIS ACCESS-RELATED INFECTION

C1 Haemodialysis

Introduction

Catheters are essential medical device for the provision of temporary and long-term vascular access for HD. Both uncuffed and cuffed tunnelled catheters have been used as vascular access for HD patient. In this context, there is a growing trend to use the latter as a long-term vascular access, especially in elderly patients as well as patients with poor cardiovascular disease or diabetes mellitus.[19] The use of HD catheter is associated with HD catheter-related infections such as exit-site infections, catheter-related bloodstream infections (CRBI) or even infective endocarditis, and such risks are increased with duration of placement.[20] Hence, the prevention of HD catheter-related infection significantly improves outcomes in HD patients.

Guideline statements

C1.1. The internal jugular veins are the preferred sites for HD catheter placement. Insertion into femoral veins, especially for tunnelled cuffed catheters, is not encouraged unless jugular vein cannulation is not possible. (R)

C1.2. Aseptic technique should be employed during insertion, manipulation and connection/disconnection of HD catheter. The exit site of HD catheter should be covered by sterile dressing which should be inspected during each HD session and be replaced if no longer clean or intact. (R)

C1.3. The use of antibiotics lock solution can reduce risk of HD CRBI, but its use should be balanced against the benefits and associated risks and should not replace hygienic standards about catheter handling. (D)

C1.4. Application of topical antimicrobial to exit site of HD catheter is not a routine practice in HD catheters, and should be weighed against the emergence of resistant organisms. (D)

Rationale

Femoral positions are at high risk of infection and bacteremia and hence should be avoided if possible as site of HD catheters.[21,22] Alternative sites include subclavian veins but are associated with increased risk of stenosis.[20] Weighed against risks and benefits, the internal jugular veins remain the preferred sites for HD catheter placement.

Although the evidence regarding the use of disposable face masks and gowns protect against the transmission of staphylococcus and other organisms is not convincing,[23] the use of face masks and gowns is relatively harmless and should be undertaken during HD catheter insertions. The HD catheter exit site should always be covered by sterile dressing as long as the catheter is in-situ. One meta-analysis showed that transparent dressing is associated with higher risk of catheter sepsis and bacteremia when compared with gauze dressings.[24] Inspection of the catheter exit site during each HD session facilitates earlier detection and treatment of exit-site infection, and hence helps prevent CRBI. Moreover, the sterile gauze should be replaced when it becomes wet or unclean.

There is mounting evidence to suggest efficacy of antimicrobial locks. Citrate, alcohol, ethylene diamine and antimicrobials have been tested as antimicrobial lock solution.[25–29] Among these agents, the clinical efficacy of citrate had been established in at least two meta-analyses.[25,26] In this context, low concentration (4%) of citrate is preferred to high concentration (>30%) as spillover of the latter into systemic circulation might lead to abrupt hypocalcaemia and cardiac complications,[30,31] pulmonary embolism and systemic toxicities of antibiotics (e.g. ototoxicity in aminoglycosides).[30,32] Hence, the use of antimicrobial lock should be balanced against the benefits and risks in different clinical contexts.

Previous studies have demonstrated the benefits of topical application of antimicrobials on reduction of HD catheter exit-site infections and associated bloodstream sepsis.[33–35] Mupirocin, MediHoney, polysporin triple ointment (Bacitracin, gramicidin and polymixin B) have been used as topical prophylaxis for HD catheter exit sites.[33,34,36,37] In this context, mupirocin and MediHoney have shown similar clinical efficacy and the latter is associated with a theoretically lower risk of resistance.[36]

Limitations

There is limited data to compare the efficacy and costs of different approach to prevention of catheter-related infections. While there is abundant data on nasal application of mupirocin in PD on reduction of exit-site and tunnel tract infection as well as peritonitis, such evidence in HD catheter remains lacking.

Implementation issues

Adherence to standard precautions and aseptic techniques during the handling of HD catheters can be difficult, especially in HD centres with high patient load and turn-over. The emergence of resistant organisms also remains an important issue in HD catheter-related infections.

Audit items

The compliance to standard precautions and aseptic technique during the handling of HD catheter should be continuously reviewed. The rates of HD catheter exit-site infections and CRBI, as well as the organism identified (including the susceptibility profile) should also be regularly audited. Such data will help review and modify current policy for the prevention of HD catheter-related infections in a dialysis unit.

C2 Peritoneal dialysis

Introduction

PD catheter-related infections (i.e. exit-site and tunnel-tract infection) are major risk factors for peritonitis and hence

prevention of PD catheter-related infections can significantly decrease risk of peritonitis.[38,39]

Guideline statements

C2.1. Proper hand hygiene should be undertaken by patients, helpers and health-care providers during the handling and manipulation of the PD catheter and its exit site. (R)

C2.2. The use of antimicrobials with activity against *S. aureus* as exit-site prophylaxis in PD patients is recommended. (R)

C2.3. Intra-nasal application of mupirocin in PD patients with confirmed nasal carriage of *S. aureus* is recommended. (R)

Rationale

Proper hand hygiene is a crucial measure to reduce PD exit-site infections, and should be undertaken by patients, helpers and health-care providers during routine handling of the PD catheter and its exit site.[40] In this context, 70% alcohol-based hand rub is recommended as the most effective hand-cleansing agent before and after exit-site care.[41] Other alternative include handwashing with antimicrobial-containing (e.g. 4% chlorhexidine) soap.[41] Polished nails increase the risk of bacterial contamination with hands and should be avoided in patients, helpers and health-care providers for PD patients.[41]

Mupirocin has established efficacy as prophylaxis for *S. aureus* exit-site infections.[42–47] The use of intra-nasal mupirocin has been examined in a large multicentre trial which showed that the use of intra-nasal mupirocin in PD patients with confirmed nasal *S. aureus* carriage decreased exit-site infection but not peritonitis.[48] However, there is little data regarding the comparative efficacy between the intra-nasal *versus* exit-site application of mupirocin. While the use of mupirocin prophylaxis has resulted in reduced *S. aureus* infection in PD patients, *Pseudomonas aeruginosa* remains a significant issue for exit-site infections. A multicentre double-blind randomized trial compared the use of daily gentamicin ointment *versus* daily mupirocin ointment as exit-site prophylaxis. The results demonstrated that gentamicin ointment had similar efficacy for preventing *S. aureus* exit-site infection as mupirocin but with an added value of preventing *Pseudomonas* exit-site infections. Other emerging prophylactic therapies for PD exit site include the use of MediHoney and Polysporin triple (Bacitracin, gramicidin and polymixin B) ointment.[49–54]

Limitations

There is limited data regarding the comparative effectiveness between exit-site application *versus* intra-nasal application of mupirocin ointment.

Implementation issues

Adherence to proper hand hygiene during the care of PD catheter exit sites can be difficult, especially in elderly PD patients as well as health-care workers who work in PD centres with high patient load. The increasing prevalence of anti-microbial resistant organisms (especially methicillin-resistant *S. aureus*) also presents a significant problem in PD exit-site infections.

Audit items

The compliance to standard precautions and aseptic technique during the handling of PD catheter should be continuously audited. The rates and causative organisms (including antibiotics susceptibility) of PD catheter exit-site infections and peritonitis should also be regularly monitored. These data can help guide the change in exit-site prophylaxis policy in a PD unit.

D PREVENTION AND MANAGEMENT OF BLOOD BORNE VIRUS INFECTION

D1 General guideline statements

1. The renal unit should have in place a comprehensive blood borne virus (BBV) protocol to prevent the transmission, minimize the incidence, facilitate early detection and guide the management of BBV infections. [R]
2. Standard operating procedures with regular reinforcement should be in place to ensure strict compliance with infection control measures. [R]
3. A surveillance program should be in place to test for evidence of BBV infections in dialysis patients at regular intervals. [R]
4. Dialysis equipment should be designated and segregated according to HBV status, that is, labelled as 'HBV-positive' or 'HBV-negative'. Ideally, dialysis equipment should be designated and segregated according to hepatitis C virus (HCV) and human immunodeficiency virus (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. [R]

Comments

Major reasons for the transmission of BBV in dialysis units include breaches in standard precautions or infection control good practice, or failure to identify and isolate patients infected with BBV, especially the recently infected individuals.

D2 Serological screening for HBV, HCV and HIV

Guideline statements

1. hepatitis B s antigen (HBsAg), anti-HBs, anti-HBc (see Note below), anti-HCV, anti-HIV and alanine aminotransferase (ALT) level should be tested in dialysis

patients and in potential kidney transplant recipients at baseline, that is, prior to commencing dialysis, preferably at presentation. [R]
2. Testing for viral hepatitis markers (and other microbiological agents as clinically indicated) should be performed in susceptible individuals when there is clinical or biochemical evidence of hepatitis. [R]
3. In patients susceptible to HBV infection (i.e. who are negative for both HBsAg and anti-HBs), HBsAg is to be tested every 6 months in patients on HD [R], and annually in patients on PD [D]. In HD patients who are positive for anti-HBs antibody, testing for anti-HBs should be repeated annually and patients should be given a booster dose of HBV vaccine when anti-HBs level is below 10 IU/L. [R]
4. Patients with acute hepatitis B or C should have follow-up virological tests to determine whether they have developed immunity or have become long-term carriers. [R]
5. Testing for HCV RNA should be considered in anti-HCV negative dialysis or kidney transplant patients when HCV infection is strongly suspected [D], and is mandatory when the result informs treatment decisions. [R]
6. Since anti-HCV often remains persistently positive even after successful antiviral treatment, testing for HCV RNA in blood sample is required when it is necessary to determine the current HCV carrier status in such patients. [R]

Note

1. In patients who have tested negative for both HBsAg and anti-HBs but positive for anti-HBc, testing for HBV DNA should be performed. A patient who has tested negative for HBsAg and anti-HBs and HBV DNA, but positive for anti-HBc, should be dialyzed with an 'HBV-negative' HD machine, whereas a patient who has tested negative for HBsAg and anti-HBs, but positive for both anti-HBc and HBV DNA, should be dialyzed with an 'HBV-positive' HD machine, and segregated as such during HD.
2. When HD is urgently required in a patient who has tested negative for both HBsAg and anti-HBs –
   a. if the results of both anti-HBc and HBV DNA are not known, the patient should be dialyzed with an HD machine designated for patients with 'UNKNOWN HBV Status' when available. In units which only have 'HBV-positive' or 'HBV-negative' HD machines for the purpose of urgent HD, an 'HBV-negative' machine should be used; or
   b. if the patient is positive for anti-HBc but the result of HBV DNA is not known, the patient should be dialyzed with an HD machine designated for patients with 'UNKNOWN HBV Status' when available. In units which only have 'HBV-positive' or 'HBV-negative' HD machines for the purpose of urgent HD, an 'HBV-negative' machine should be used; and
   c. the 'HBV status' of the patient may need to be amended and updated when the results of both anti-HBc and HBV DNA are available.
3. HBV DNA may change from positive to negative as a result of treatment or spontaneously. A known chronic HBV carrier, based on serological profile or previous HBV

Summary of serological testing schedule for HBV, HCV and HIV in dialysis patients.

	Haemodialysis	Peritoneal dialysis	Comments
A. Prior to commencing dialysis			
All patients	HBsAg, anti-HBs, anti-HBc, anti-HCV, ALT, anti-HIV	HBsAg, anti-HBs, anti-HBc, anti-HCV, ALT, anti-HIV	a. HBV DNA test is indicated in HD patients who are HBsAg negative and anti-HBs negative but anti-HBc positive b. Testing for HBV DNA in subjects who are HBsAg negative, anti-HBs positive, and anti-HBc positive is done when clinically indicated, for example, when potent immunosuppressive treatment is being considered c. Irrespective of anti-HCV status, testing for HCV RNA is indicated to determine the current HCV carrier status in patients who have previously received anti-viral treatment
B. After commencing long-term dialysis			
Patients who are HBsAg negative and anti-HBs negative and anti-HBc positive or negative	HBsAg half-yearly	HBsAg annually	–
Patients who are HBsAg negative and with anti-HBs >10 IU/L	anti-HBs annually	anti-HBs annually	booster HBV vaccine advisable when anti-HBs ≤10 IU/L
Patients who are HBsAg positive	HBsAg annually	–	–
Patients who are anti-HCV negative	anti-HCV half-yearly	–	–
Patients who are anti-HCV positive	anti-HCV annually	anti-HCV annually	when HCV reactivation is suspected in known responders to prior HCV treatment, HCV RNA test is indicated irrespective of anti-HCV status
Patients either anti-HIV positive or negative	anti-HIV annually	–	–

DNA result tested outside the primary infection time-frame, should always remain in the category of 'HBV-positive', even when the latest HBV DNA status is negative (see summary table).

D3 Management of patients with HBV infection

Guideline statements

1. Regular monitoring of liver disease parameters and surveillance for HBV-associated complications are obligatory in patient management. [R]
2. HD patients who are chronic HBV carriers should be dialyzed with 'HBV-positive' machines and in segregated HBV-positive areas away from patients without HBV infection. [R]
3. Preventive antiviral treatment is necessary in patients with chronic HBV infection who are given potent immunosuppressive therapies, including immunosuppressive medications after kidney transplantation [R]. Currently, prophylactic treatment with entecavir is recommended. [R]

Comments

Patients with chronic HBV infection are at markedly increased risk of developing liver complications such as cirrhosis and hepatocellular carcinoma. It is therefore necessary to regularly monitor their liver status and to perform regular surveillance investigations for hepatocellular carcinoma including blood level of alpha-fetoprotein and liver imaging.

Both machine and spatial segregation are recommended for HD patients with chronic HBV infection since failure to do so has been associated with an increased incidence of HBV infection in the dialysis unit. HBV DNA may change from positive to negative as a result of treatment or spontaneously. A known chronic HBV carrier, based on serological profile or previous HBV DNA result tested outside the primary infection time-frame, should always be regarded as 'HBV-positive', even when the latest HBV DNA status is negative.

HBV-associated liver disease is often relatively stable in patients on long-term dialysis, but immunosuppression can precipitate HBV reactivation and accelerate liver disease progression. Preventive antiviral therapy for patients infected with HBV who are given immunosuppressive medications can be administered as prophylactic treatment commencing at the time of immunosuppression or as preemptive treatment upon detection of increased viral replication as evidenced by increasing HBV DNA levels in serial blood samples. However, the latter approach should only be adopted when there is access to frequent HBV DNA assays with a rapid turn-around time. Under the setting of a busy clinical service, the prophylactic approach is preferred. Presently entecavir is the preferred antiviral treatment for HBV in patients with renal diseases because of its high efficacy and high barrier to the development of drug resistance and also renal safety.

D4 Management of patients with HCV infection

Guideline statements

1. Sero-positivity for HCV RNA by polymerase chain reaction (PCR) assay is required for the diagnosis of current (active) HCV infection. Testing for HCV RNA is advisable in patients in whom HCV infection is strongly suspected based on clinical grounds but who are sero-negative for anti-HCV, since a low percentage (<5%) of patients with impaired immunity may be anti-HCV negative but HCV RNA positive. [D]
2. Patients with a history of viral clearance after prior HCV infection, either spontaneous or consequent to therapy, can remain sero-positive for anti-HCV for many years, and testing for HCV RNA is required to diagnose HCV recurrence or reinfection. [R]
3. Though not obligatory, machine and spatial segregation is preferred for HCV-infected HD patients in a dialysis unit, especially in units with a relatively high prevalence of HCV sero-positivity. [D]
4. Quantitation of circulating HCV RNA level is necessary before starting antiviral treatment. [R]
5. In patients with active HCV infection, testing for HCV genotype(s) is recommended to guide the selection of antiviral treatment [R]. It is also desirable to assess liver fibrosis by non-invasive means before treatment. [D]
6. The field of direct-acting antiviral (DAA) regimens for the treatment of HCV infection is evolving rapidly. Treatment decisions take into account HCV genotype, efficacy and tolerability, affordability and confounding patient characteristics, and require input from hepatologists and patient counselling. [R]
7. Patients with severe manifestations of HCV-associated liver disease, including fibrosing cholestatic hepatitis, or extra-renal manifestations, such as cryoglobulinemic syndromes or renal manifestations, are ascribed higher priority when considering antiviral treatment. [D]
8. Regular monitoring of liver disease status and surveillance for HCV-associated complications are obligatory in patient management. [R]

Comments

In HD units, both horizontal transmission (between patients in the same unit not sharing HD machines) and vertical transmission (between patients sharing HD machines) of HCV infection have been reported. However, inadequate infection control practices rather than machine or space segregation were often the main reasons for these outbreaks.

Machine and/or spatial segregation are encouraged, if deemed feasible, for HCV-infected HD patients.

In Hong Kong, the HCV carrier rate in the general population is below 0.5%. There is marked geographical variation in the distribution of HCV genotypes globally, and 1b is the predominant genotype in patients on renal replacement therapies in Hong Kong, although other genotypes have also been detected and mixed infection by different genotypes can occur.

Previous standard treatment for HCV comprising pegylated interferon and ribavirin, which was associated with suboptimal efficacy and considerable adverse effects especially in patients with kidney diseases, are being replaced with oral DAA, which demonstrate much improved efficacy in achieving viral eradication. DAA drugs for the treatment of HCV infection are protease inhibitors or polymerase inhibitors that target different steps in the viral life-cycle, such as post-translation processing of polyproteins and RNA replication, respectively. There are ongoing studies on different DAA treatment regimens and the field is evolving rapidly with the availability of new data. Treatment efficacy and the optimal combination regimen and/or duration vary according to HCV genotypes.

Similar to HBV, immunosuppressive treatment can precipitate HCV reactivation and disease flare. However, there is relatively little data on preventive antiviral therapy for patients with kidney diseases who are infected with HCV. The timing and choice of treatment under such circumstances are to be individualized and require input from hepatologists.

D5 Management of patients with HIV infection

Guideline statements

1. Machine and spatial segregation is preferred, but not obligatory, for HIV-infected HD patients. [D]
2. Irrespective of machine designation, it is advisable to separate HIV-infected subjects from susceptible patients during HD. [D]
3. HIV-infected patients should be under the care of a relevant infection specialist team and managed according to prevailing standards. [R]

D6 Management of newly diagnosed BBV infection

Guideline statements

1. Subjects with confirmed acute BBV infection should be treated according to current standard-of-care regimens, such as entecavir for HBV and DAA for HCV. [R]
2. Patients with newly diagnosed BBV infection should be counselled with regard to the disease course and its complications and infection control measures, and the source of infection investigated. [R]
3. When there is a newly diagnosed BBV infection in a dialysis unit, testing for the respective BBV infection should be conducted in other patients who have a risk of BBV exposure, such as those who have shared dialysis session or machine with the newly infected index case. [R]

D7 Management of patients or staff with BBV exposure

Guideline statements

1. Reporting of incident(s) of BBV exposure should follow prevailing institutional guidelines. [R]
2. In cases of inadvertent exposure to potentially infectious material, the source and the exposed person (patient or staff) should be tested for the status of BBVs. [R]
3. Susceptible persons exposed to the risk of BBV infection should be counselled to adopt precautionary measures to prevent secondary transmission until investigations confirmed no transmission of infection due to the exposure. [R]
4. Susceptible patients or staff, and subjects with unknown HBV status, who have exposure to HBV should be tested for HBsAg, anti-HBs, anti-HBc and ALT levels immediately after exposure. HBsAg status should be tested again at 4, 8 and 12 weeks after exposure to ascertain whether infection has occurred. [R]
5. Susceptible patients or staff members who have inadvertent exposure to potential HBV infection should receive timely hepatitis B immune globulin and vaccination [R]. In subjects given both HBV vaccine and hepatitis B immune globulin the anti-HBs response can only be reliably ascertained after at least 4 months. [R]
6. Anti-HBs status should be tested when a subject exposed to potential HBV infection has prior HBV vaccination but unknown anti-HBs response. No treatment is necessary if anti-HBs level is adequate (i.e. above 10 IU/L), while hepatitis B immune globulin and vaccine booster should be given when the anti-HBs level is inadequate. [R]
7. Interferon with or without ribavirin are not recommended as post-exposure prophylaxis for HCV. [R]
8. Susceptible patients or staff who have inadvertent exposure to HCV should be tested for anti-HCV, HCV RNA and ALT levels immediately after exposure, with repeat testing for HCV RNA after 4 weeks and repeat testing for anti-HCV after 16 and 24 weeks to ascertain whether infection has occurred [R]. Hepatologists should be consulted for further management.
9. Patients or staff who have inadvertent exposure to HIV should be given prophylactic antiretroviral treatment, the current recommendation for which is a three-drug regimen for 4 weeks, and the choice of medications

should take into consideration the drug susceptibility/resistance status of the virus in the source person. [R]
10. Susceptible patients or staff who have inadvertent exposure to HIV should be tested for anti-HIV status immediately after exposure, with repeat testing after 6 weeks, 12 weeks and 6 months [R]. When the source is coinfected with both HIV and HCV and the exposed person has acquired HCV after the exposure incident, extended follow-up testing for anti-HIV up to 12 months is recommended. [R]
11. Patients who have received dialysis, blood products, or kidney allograft with uncertain BBV status, including having such procedures outside Hong Kong, should be regarded as exposed to potential BBV infection and managed accordingly. [R]

Comments

It is desirable that staff members be tested for HBsAg and anti-HBs before joining the renal unit, and HBV vaccination is recommended for individuals who are susceptible to HBV infection (HBsAg and anti-HBs both negative). It is advisable that staff members who are sero-negative for anti-HBs be tested for HBsAg status at least annually. It is advisable that HBV-infected staff members refrain from carrying out invasive procedures in patients who are susceptible to HBV infection.

Testing for anti-HCV in staff need not be routine in our locality in view of the low HCV carrier rate in the general population, but is recommended in individuals with identifiable risk factors for HCV infection or a history of non-A non-B hepatitis. Similar to the case for HBV, it is advisable that HCV-infected staff members refrain from carrying out invasive procedures in patients who are susceptible to HCV infection.

When HBV infection occurs after exposure to HBV, seroconversion to become HBsAg-positive occurs anytime between 1 and 9 weeks after exposure. Subjects may recover from the acute infection with clearance of HBsAg from blood and production of anti-HBs, the latter being detectable months after the onset of infection, or may become long-term HBV carriers.

In acute HCV infection, there is an initial 'eclipse phase' lasting 1–2 weeks during which HCV RNA is not yet detectable in blood. Also, HCV RNA level may fluctuate during the early course of infection. Anti-HCV is usually detectable anytime between 8 and 12 weeks after infection, often after the onset of symptoms or abnormal liver enzyme levels. The time interval from infection to sero-positivity for anti-HCV is termed the 'window period'. Sero-positivity for anti-HCV does not distinguish between acute infection and chronic infection.

While interferon, with or without ribavirin, is not recommended as post-exposure prophylaxis for HCV, and there is little data on DAAs in this regard, it is reasonable to consider DAA therapy in the exposed person. Hepatologists should be consulted with regard to further management.

It is recommended that post-exposure prophylactic treatment for HIV includes a minimum of three antiretroviral drugs for 4 weeks. However, some subjects may not be able to complete the full treatment duration due to poor drug tolerability. Opinion on the treatment of patients should be sought from an infectious disease specialist.

D8 Immunization

Guideline statements

1. Immunization programs should be in place to ensure that patients with kidney diseases are vaccinated early in the course of progressive renal impairment to maximize the chance of achieving protective immunity. [R]
2. Live or live-attenuated vaccines must not be administered to immunosuppressed patients including kidney transplant recipients [R], and are not preferred in patients with moderate to severe renal impairment. [D]
3. HBV vaccination is indicated in patients with chronic kidney diseases who are sero-negative for both HBsAg and anti-HBs [R]. Testing for anti-HBs antibody response should be performed 2–3 months after completion of the vaccination schedule. [R]
4. In dialysis patients who have a history of sero-positivity for anti-HBs, reassessment of anti-HBs status annually is indicated for patients on HD [R], and is advisable for patients on PD or after kidney transplantation [D]. It is desirable that booster HBV vaccine be administered when anti-HBs level is less than 10 IU/L. [D]
5. The dose of HBV vaccine should be doubled in patients with moderate to severe renal impairment and in immunosuppressed kidney transplant recipients. [R]
6. Influenza vaccination is recommended in patients with moderate to severe renal impairment, patients on dialysis, and kidney transplant recipients. [R]
7. Pneumococcal vaccination reduces the incidence of invasive pneumococcal disease and is recommended for patients with chronic kidney disease or nephrotic syndrome and for kidney transplant recipients. [R]

Comments

HBV – Compared with immunocompetent adults, in whom adequate anti-HBs response occurs in over 95% after HBV vaccination, the immunization efficacy is reduced (median 60–70%) in dialysis patients and immunosuppressed kidney transplant recipients. Patients should be vaccinated according to the standard intramuscular schedule over 6 months, and the dose should be doubled in patients with moderate to severe renal impairment, patients receiving immunosuppressive medications, and kidney transplant recipients. In patients who are scheduled to undergo kidney transplantation within 6 months, an accelerated vaccination schedule with three to

four doses of vaccine given monthly can be considered. In non-immune kidney transplant recipients, delaying HBV vaccination for 6–12 months after the transplant operation may increase the immunization efficacy. HBV infection has been observed in dialysis patients with prior anti-HBs response after vaccination but whose prevailing anti-HBs level was below 10 IU/L. Therefore, booster dose of HBV vaccine is recommended for patients with prior anti-HBs but whose anti-HBs level has fallen to 10 IU/L or below. Subjects who have not responded to one course of HBV vaccination should be given another course of vaccine, and if it still fails to induce anti-HBs additional dose of vaccine is not warranted.[55–62]

Influenza – Patients with moderate to severe renal impairment and immunosuppressed subjects including kidney transplant recipients should receive annual influenza vaccination with inactivated vaccine, not live-attenuated vaccine, prior to commencement of influenza activity in the local community.

Pneumococcal – Pneumococcal vaccination reduces the incidence of invasive pneumococcal disease such as bacteremia, meningitis and empyema, and it reduces the severity of virus-associated pneumonia with pneumococcal co-infection. Pneumococcal vaccination is recommended for all adults at or above the age of 65 years and for subjects of age 19–64 years at increased risk of pneumococcal disease or its complications, including patients with anatomic or functional asplenia, chronic kidney disease, nephrotic syndrome or after kidney transplantation. Patients who have not previously received 23-valent pneumococcal polysaccharide vaccine (PPSV23) or 13-valent pneumococcal conjugate vaccine (PCV13) should receive one dose of PCV13 first, followed by one dose of PPSV23 8 weeks later, and one more dose of PPSV23 5 years later. Patients who have previously received PCV13 only should be given PPSV23 as described above. Patients who have previously received one or more doses of PPSV23 only should be given one dose of PCV13 at 1 year or more after the last dose of PPSV23.

E INFECTION PROPHYLAXIS IN THE KIDNEY TRANSPLANT RECIPIENTS

E1 Pre-transplant evaluation and immunization

Introduction

Infection is a common and important complication in kidney transplantation recipients (KTR), and is associated with appreciable patient morbidity and mortality.[63,64] Infection in KTR can be donor-derived or reactivations of previous infections. Hence, infection screening of both the donors (live and deceased) as well as the recipients constitutes a key role in the prevention of post-transplant infections. The difference between infection screening for live donor and deceased donor transplantation is related to time constraints. For live donor kidney transplantation, clinicians have ample time to screen and treat infections, to decline unsuitable donors, and find other potential donors if necessary. In deceased donor kidney transplantation, in the interest of time, testing is often limited to serological methods which are readily available and with fast turn-around time. While proper screening can minimize post-transplant infective risks, immunization can also serve as an effective means to prevent post-transplant infectious disease.

Guideline statements

E1.1. HBsAg, anti-HBs, anti-HBc, anti-HCV, anti-HIV, serology for cytomegalovirus (CMV), Epstein Barr Virus (EBV) and Varicella Zoster Virus (VZV) and syphilis venereal disease research laboratory (VDRL) should be checked in both the donor and recipient before kidney transplantation. (R)

E1.2. hepatitis B e antigen (HBeAg) and HBV DNA should be checked in HBsAg-positive patients before kidney transplant. (R)

E1.3.Chest radiography should be performed in all recipients for kidney transplantation to look for latent tuberculosis (TB) infection. (R)

E1.4. Patients who are HBsAg and anti-HBs negative should receive HBV vaccination before kidney transplantation. (R)

Rationale

The HBV and HCV should be ascertained in the donor and recipient before renal transplantation. HBV infection confers adverse outcomes in KTR due to acute hepatic complications such as fulminant hepatitis/fibrosing cholestatic hepatitis or chronic complications such as cirrhosis and hepatocellular carcinoma.[65,66] Careful matching of the donor/recipient HBV status is an important step to prevent HBV transmission during renal transplantation. Chronic HBV infection in the recipient is not a contraindication of kidney transplantation. In HBsAg-positive transplant candidates, the HBeAg and HBV DNA levels should also be evaluated as HBeAg positivity and high HBV DNA levels are associated with increased risk of HBV reactivation after renal transplantation.[67] Renal transplantation when both donor and recipient are both HBsAg-positive is also possible, especially in localities with high prevalence of HBV carrier and organ shortage. The use of the HBsAg negative but anti-HBc positive donor is slightly more complex. The risk of transmission to kidney recipients appears to be low though has been reported.[68,69] Such risk can be further reduced by pre-transplant HBV vaccination, use of HBV immunoglobulin (HBIG) and/or in combination of oral nucleostide/tide analogues.[70–72] HBV vaccination is an effective means to prevent HBV transmission and hence should be administered to dialysis patients who are HBsAg-negative and anti-HBs negative. The efficacy of HBV vaccine might be reduced in renal failure and higher dose of vaccine is advocated.[73] Intradermal HBV vaccine can be considered in patients who fail to mount protective antibodies (i.e. anti-HBs) after standard HBV immunization.[74]

The risk of transmission of HCV infection associated with organ transplantation from an HCV-positive donor is high, and HCV-negative recipients who received an HCV-positive kidney had significantly adverse outcomes.[75,76] These data suggested a HCV-positive kidney should not be transplanted to a HCV-negative recipient. It remains optimistic that advances in donor/recipient matching with respective to genotypes and the use of novel anti-HCV treatments may further improve the safety of these HCV-positive renal transplants in the future.

Human immunodeficiency virus infection in the recipient is previously considered a contraindication for renal transplantation. Mounting evidence has suggested that such renal transplantation in carefully selected patients can be associated with acceptable clinical outcomes. A prospective study have examined the outcomes of renal transplantation in 150 HIV-positive recipients who had CD4+ T-cell counts greater than 200/cm^3 and undetectable HIV RNA.[77]

The CMV and VZV serological status of donor and recipient will help determine the risk of post-transplant infection and hence guide clinician decisions for prophylaxis. The prophylactic strategies for CMV and VZV will be discussed in subsequent sections. EBV is highly associated with post-transplant lymphoproliferative disease (PTLD).[78] Transmission of syphilis by renal transplantation and has been reported and syphilis infection can have severe clinical manifestation in renal transplant recipients.[79] Nevertheless, syphilis is not a contraindication of renal transplantation if each recipient receives an appropriate course of post-transplant penicillin.[79]

Tuberculosis is endemic infection in the Asia-Pacific region. TB infection in KTR is associated with substantial mortality (~20–30%) and the majority of cases are due to reactivation of old infective foci.[80,81] Chest radiography should be performed in all recipients to exclude latent or old TB, especially in localities where TB is endemic.[82] The detection of these radiological abnormalities will prompt clinicians to use isoniazid prophylaxis.[83]

Limitations

Donors with high risk of HIV or HCV might have false-negative results during the window period and more sensitive tests such nucleic acid-based assays might be warranted. These sensitive tests, however, might give rise to false positive results and hence limit organ availability. VDRL can also give rise to false-negative and false-negative results, and more accurate tests might lead to resource implications and slower turn-around time. Limitation of using skin tuberculin tests to screen latent TB include: (i) most Hong Kong people have previous bacillus calmette–guérin (BCG) vaccination and hence skin tuberculin tests are often false-positive; (ii) impaired immunological response dialysis patients can give rise to false-negative skin tuberculin test results. There is also limited local experience regarding renal transplantation in HIV-positive recipients.

Implementation issues

Nucleic acid based tests for viral infections and interferon-gamma release assays for latent TB might be an alternative but the costs remain significant hindrance to its widespread application in different centres in Hong Kong.

Audit measures

The rate of donor-derived infection and reactivation of previous infections should be regularly monitored and audited. A changing pattern of disease might warrant modifications in strategy for donor/recipient screening and prophylaxis.

E2 Peri-transplant antimicrobial prophylaxis

Introduction

Peri-operative antibiotics prophylaxis remains a cornerstone for the prevention of early post-transplant infections. While conventional perioperative antibiotics prophylaxis protocol had been adopted widely in various centres, novel antibiotics have been introduced to provide enhanced efficacy and spectrum of coverage to prevent early post-transplant infections.[84–86]

Guideline statements

E2.1. A second or third generation cephalosporin should be used as peri-transplant antibiotics prophylaxis and discontinued within 24 h. (R)

Background

There is a paucity of randomized studies to address the need for peri-transplant antibiotics prophylaxis. While Cohen *et al*. reported a reduction in post-transplant infections during the first 5 days among patients who received peri-transplant antibiotics prophylaxis when compared with those who did not receive antibiotics prophylaxis (11 *vs* 42%),[85] others had shown a similar rate of urinary tract infection (UTI) in KTR with or without peri-transplant antibiotics prophylaxis.[87] In this regard, one large study had observed high rates of UTI (73.7%) in KTR who did not receive peri-transplant antibiotics prophylaxis.[88] In a Europe-wide survey, 83% of the transplant centres had adopted a peri-transplant antibiotics protocol with second or third generation cephalosporins being the most commonly used antibiotics.[89]

Limitations

There is lack of prospective randomized trial data to suggest the clinical benefit of peri-operative antibiotics prophylaxis. The variable length of observation for post-transplant infections among different studies had made comparison of results difficult and inconclusive. Furthermore, the use of second or third generation cephalosporins is associated with selection of multidrug-resistant organisms (MDRO).

Implementation issues

Dialysis patients on transplant-waiting list are of escalated risk of MDRO. The use of second or third generation cephalosporins may be ineffective in centres with high rates of extended spectrum beta-lactamase (ESBL)-producing organisms or multidrug-resistant pathogens.

Audit measures

The rates and types of early post-transplant infections should be periodically reviewed. These data will help evaluate the efficacy of the current peri-transplant antibiotics regimen.

E3 Post-transplant antimicrobial prophylaxis

E3.1 Cytomegalovirus

Cytomegalovirus is one of the most common and important viral infections among KTR. Important risk factors for CMV reactivation after solid organ transplantation include recent intensification of immunosuppressive regimen and the use of lymphocyte-depleting agents.[90,91] The approach to CMV prevention varies between patients and is dependent on individual's risk profile.

Guideline statements

E3.1.1. CMV pp65 antigen or PCR should be used for the rapid diagnosis of CMV disease. (R)

E3.1.2. CMV pp65 antigen should be monitored at least weekly for 12 weeks after renal transplantation when a pre-emptive approach is adopted. (D)

E3.1.2. Prophylactic oral valganciclovir should be used in D+/R− cases or those who receive anti-thymocyte therapy (either as induction or anti-rejection treatment) for at least 6 months. Oral or IV ganciclovir can be considered as alternatives for oral valganciclovir. Close surveillance for CMV disease is mandatory after stopping prophylactic treatment. (R)

E3.1.3. Both pre-emptive and prophylactic approach can be considered in renal transplant recipients who are CMV seropositive. (D)

E3.1.4. For the pre-emptive approach, valganciclovir (900 mg bd PO) or IV ganciclovir (5 mg/kg, q12h) should be initiated when CMV pp65 > 40 positive cells/2×10^5 cells and be discontinued when two consecutive weekly CMV pp65 antigen sample has become negative. (R)

Rationale

The CMV pp65 antigen served as good assay for the diagnosis of CMV disease and also for the monitoring of therapeutic response.[92] It has the advantage of rapid turn-around time and high sensitivity.[92] One disadvantage of CMV pp65 assay is the false-negative results when patients suffered from leucopenia.[92] In this context, nucleic acid tests such as CMV PCR might better reflect CMV replication.[92,93] In fact, quantitative nucleic acid tests are growing in popularity as methods for the diagnosis of CMV infection after solid organ transplantation. Viral culture show high specificity for diagnosis of CMV infection. However, its application is limited by its modest sensitivity and slow turn-around time which rendered this test unfavourable for guiding treatment decisions.[92]

The prophylactic approach refers to the prescription of anti-viral agent to all 'at-risk' patients for a defined period after solid organ transplantation, and regardless of the CMVpp65 antigen or CMV PCR results. Oral valganciclovir, oral or IV ganciclovir and oral valacyclovir are all effective prophylaxis for CMV infection.[94–97] While all three agents have shown efficacy in randomized clinical trials, valganciclovir is the preferred prophylaxis for CMV infection. In one randomized controlled trial which compared valganciclovir and ganciclovir, both drugs have demonstrated similar efficacy in preventing CMV disease (17.2 *vs* 18.4%).[94] In this context, valganciclovir has the advantage of good bioavailability and lower pill burden. The clinical benefit of valganciclovir was further supported by another prospective randomized trial which included 318 CMV D+R− kidney transplant recipients. This study compared the different treatment duration of valganciclovir (100 *vs* 200 days), and concluded that the latter was associated with significantly lower incidence of CMV disease (36.8 *vs* 16.1%).[98] Based on these results, the prophylactic approach is preferred in KTR who are D+R− and a 200-day course of valganciclovir appeared to be the optimal prophylaxis. Compared with the pre-emptive approach, the efficacy of the prophylactic approach was supported by more large randomized trials and was associated with clinical benefits on graft outcomes, mortality and other opportunistic infections.[99] However, the prophylactic approach was also associated with higher treatment costs and increased risk of myelosuppression and late-onset CMV disease. The pre-emptive approach refers to regular monitoring of viral replication and initiation of anti-viral treatment when a certain virological threshold is reached. The prerequisite of pre-emptive include good coordination of patients for regular monitoring and fast turn-around time of laboratory tests. Oral valganciclovir and IV ganciclovir are both effective agents for pre-emptive treatment in asymptomatic CMV reactivation.[100,101] Other merits of the pre-emptive approach include lower drug costs and potentially less treatment toxicity with shorter duration of anti-viral therapy.

Limitations

There is a paucity of data to compare the impact of prophylactic and pre-emptive approaches on long-term clinical outcomes such graft and patient survival. The optimal threshold for initiation of anti-viral therapy for the pre-emptive approach remained to be determined.

Implementation issues

Adoption of the pre-emptive approach requires fast turn-around time of CMV pp65 assays. The coordination of regular blood monitoring schedules also imposes substantial resource implications to a renal transplant unit. The use of prophylactic approach will incur increased drug budget in a nephrology unit, especially when oral valganciclovir is used as the prophylactic anti-viral agent. The high drug cost of valganciclovir also remains a hindrance to its widespread use in local renal centres.

Audit measures

Each renal unit should develop its own protocol for CMV disease monitoring and treatment. The rate of CMV disease in the renal transplant unit should be regularly audited and the preventive strategy for CMV be modified accordingly.

E3.2 Pneumocystis jiroveci

Introduction

Pneumocystis jiroveci pneumonia (PCP) classically presents with fever and dyspnoea in immunocompromised hosts and is associated with high mortality in KTR.[102] The incidence of PCP has decreased over years due to the judicious use of corticosteroids and effective prophylactic measures in KTR, but the overall incidence still ranged between 3 and 5%.[103]

Guideline statements

E3.2.1. All KTR should receive PCP prophylaxis for at least 6 months after transplantation. (R)

E3.2.2. Patients who has received anti-thymocyte therapy or has recent intensification of immunosuppression for allograft rejection should receive PCP prophylaxis. (R)

E3.3.3. Cotrimoxazole is the drug of choice for PCP prophylaxis in patients with normal glucose-6-phosphate dehydrogenase (G6PD) status.

E3.3.4. Aerosolized pentamidine (300 mg per month) can be used in patients with G6PD deficiency or allergy to co-trimoxazole. (D)

E3.3.5. When aerosolized pentamidine is not available, Tripmethoprim can be considered as second line prophylaxis for PCP infection in patients with G6PD deficiency or allergy to co-trimoxazole.

Rationale

PCP prophylaxis should be initiated in all KTR for at least 6 months after transplantation.[102–104] PCP prophylaxis should also be used in patients who had received anti-thymocyte therapy or had recent intensification of immunosuppression for allograft rejection.[102–104] In this context, cotrimoxazole is the drug of choice for PCP prophylaxis in patients with normal G6PD status.[102,105] Other potential benefits of cotrimoxazole include its efficacy for the prevention of toxoplasmosis and UTI. Inhalational pentamidine should be considered in patients with G6PD deficiency.[106] Pentamidine is generally well tolerated but is associated with higher incidence of breakthrough infections when compared with cotrimoxazole.[102,107] Other options of PCP prophylaxis include dapsone, atovaquone, as well as clindamycin and pyrimethamine.[102]

Limitations

Recent studies have suggested that late-onset PCP can occur several years after transplant recipients who have discontinued prophylaxis.[108] Whether the duration of PCP prophylaxis in KTR should be extended remains unclear, and the decision to prolong the duration of PCP prophylaxis should be individualized.

Implementation issues

There is limited choice for PCP prophylaxis when a KTR is G6PD-deficient. In this context, aerosolized pentamidine can be used as an alternative but is limited by the increased risk of breakthrough infections.

Audit measures

The incidence and timing of PCP infection should be regularly reviewed. Extending the duration of PCP prophylaxis might be considered if rising incidence of late-onset PCP infection is observed.

E3.3 Herpes zoster

Introduction

The majority of VZV infections in KTR is due to reactivation of VZV and presents as herpes zoster (shingles) which is usually confined to a single dermatome.[109–111] Occasionally, KTR who receive intensive immunosuppression (e.g. recent anti-rejection therapy) can also develop disseminated zoster infections with visceral involvement.

Guideline statements

E3.3.1. Oral acyclovir or its prodrugs (e.g. valacyclovir) are effective prophylaxis for VZV infection and can be considered in herpes simplex virus (HSV)-positive patients who are not receiving CMV prophylaxis. (D)

E3.3.2. Routine long-term prophylaxis for VZV reactivation after renal transplantation is not recommended. (R)

E3.3.3. VZV vaccine can be safely administered in dialysis patients but should not be used in KTR. (R)

E3.3.4. Post-exposure prophylaxis with intravenous immunoglobulin (IVIG) or acyclovir can be considered in seronegative KTR. (D)

Rationale

The evidence regarding the use of acyclovir prophylaxis is primarily derived from data in other immunocompromised populations.[112] Data which focuses on the efficacy of

acyclovir in KTR is lacking. In some renal units, acyclovir is already used for CMV prophylaxis after kidney transplantation and this also offer some protective effects against VZV and other herpes viruses. Short-term prophylaxis with acyclovir can be given to HSV-positive KTR who are not receiving CMV prophylaxis during the early post-transplant period.[113] There is inadequate data to suggest routine long-term administration of VZV prophylaxis in KTR.[113] There is also no guidelines regarding VZV prophylaxis after recent intensification of immunosuppressive treatments (e.g. for allograft rejection).

VZV vaccine, being a live vaccine, poses a risk of disseminated infection in KTR and thus is contraindicated in KTR.[113] Seronegative KTR are vulnerable to severe primary infection and hence should receive post-exposure prophylaxis after significant exposure to VZV. Options for post-exposure prophylaxis include passive immunization and/or anti-viral agents. While varicella zoster immunoglobulin (VZIG) is not available in many centres, IVIG appear to be a reasonable alternative as post-exposure prophylaxis.[113,114] The efficacy of anti-viral agents, when used as adjunct to VZIG, has been demonstrated in immunocompetent children and in a small study of high-risk children (five being KTR).[115–117] However, the use of acyclovir as post-exposure prophylaxis in immunocompromised hosts has not been investigated in randomized controlled trials.

Limitation

VZV immunization has limited impact on the prevention of post-transplant VZV infection as most cases are related to reactivation. There is inadequate data to suggest routine long-term oral anti-viral agents for VZV prophylaxis.

Implementation issues

The use of IVIG as post-exposure prophylaxis is associated with increased drug budget in a renal unit.

Audit measures

The incidence of VZV primary infection or reactivation should be regularly monitored. Such data will help evaluate the current strategy for VZV prophylaxis in KTRs in a renal unit.

E3.4 Tuberculosis

Introduction

TB infection in post-transplant recipients is associated with mortality as high as 20–30% and most cases are related to reactivation of old infective foci.[81,118] The diagnosis and treatment of TB reactivation are often difficult. These diagnostic challenges stem from the atypical clinical manifestations as well as inconclusive or negative test results despite active disease. Therapeutic difficulties often arise from treatment toxicities, drug resistance and potential interactions with immunosuppressive agents. Against these backgrounds, prevention of post-transplant TB reactivation is therefore worthwhile and can potentially improve patient outcomes.

Guideline statements

F3.4.1. Prophylactic isoniazid (300 mg daily) should be administered for 1 year in KTR with known previous history of TB infection. (D)

F3.4.2. Renal transplant candidates awaiting deceased donor kidney and with recent exposure or tuberculin skin test conversion should be evaluated and treated before transplantation. (D)

Rationale

One retrospective study in Hong Kong had demonstrated that isoniazid (300 mg daily) given for 12 months can effectively prevent TB reactivation in Chinese patients with previous history of TB, and such regimen is safe and well tolerated.[83] Oral pyridoxine should be prescribed with prolonged administration of isoniazid to prevent peripheral neuropathy.[82,83] Rifampicin given as prophylaxis for 4 months is not preferred due to limited data on its efficacy and it can significantly reduce the drug level of calcineurin inhibitors.[119] Dialysis patients on transplant waiting list have long waiting time in this locality and renal failure itself is an important risk factor for TB.[82] Thus, dialysis with recent exposure or tuberculin skin test conversion (i.e. from negative to positive) should be thoroughly evaluated and treated before transplantation.[82] Patients who receive prolonged isoniazid treatment should have their liver function regularly monitored although the reported risk of isoniazid-induced hepatoxicity in KTR is not higher than that in the general population.[83,120]

Limitations

While tuberculin skin test is associated with increased false-positive rates in endemic areas, it is not uncommon to have false-negative results due to anergy in renal failure patients. Therefore, it remains difficult to detect latent TB and high index of suspicion might be required. Furthermore, there is also growing concern of drug-resistant TB which limits the efficacy of isoniazid prophylaxis.

Implementation issues

The prolonged administration of isoniazid is often associated with tolerability issues such as poor appetite, nausea, vomiting and hepatotoxicity.

Audit measures

The incidence, prevalence, site and susceptibility pattern of TB infection in KTR should be periodically audited. The data will help evaluate and modify current strategy of TB prophylaxis and monitoring in a nephrology unit.

E3.5 Others (invasive fungal infections)

Introduction

Invasive fungal infection is associated with adverse graft and patient survival, as well as high treatment costs in KTRs.[121,122]

Guideline statements

E3.5.1. Routine long-term anti-fungal prophylaxis is not recommended in KTRs. (R)

E3.5.2. Oral nystatin or clotrimazole lozenges for 1–3 months can be considered in KTRs to prevent oropharyngeal candidiasis. (D)

Rationale

The risk of invasive candidiasis or aspergillosis is low after isolated kidney transplantation and there is insufficient data to recommend routine anti-fungal prophylaxis in KTRs.[121–123] The kidney disease: improving global outcomes (KDIGO), guidelines have suggested the use of oral nystatin or clotrimazole lozenges for prevention of oropharyngeal candidiasis in KTRs.[124] However, the use of azoles as anti-fungal prophylaxis in KTRs is also hindered by potential drug–drug interactions and high treatment costs.

Limitations

Although oral nystatin might be a relative cheap and safe prophylaxis for oropharyngeal candidiasis, its efficacy for other invasive fungal infections remains relatively limited. The overall risk of invasive fungal infection in KTRs is low and hence the need for anti-fungal prophylaxis remains debatable.

Implementation issues

Nystatin is only effective for the prevention for *candida* infections but has no activity against *Aspergillosis* and other fungal species. The use of azoles in KTRs should be dealt with caution due to its interaction with post-transplant immunosuppressive treatments. The novel azoles such as voriconazole and posaconazole are very effective agents with broad anti-fungal spectrum, but their high costs and potential drug–drug interaction remain important hindrance for their use as prophylaxis in most nephrology units.

Audit measures

The incidence of invasive fungal infection in a renal transplant unit should be regularly monitored. A rising incidence of invasive fungal infection should prompt the review of immunosuppressive protocols, infection control measures and the need for anti-fungal prophylaxis in a nephrology unit.

F PREVENTION AND MANAGEMENT OF MULTIDRUG-RESISTANT ORGANISM

F1 Screening

Introduction

Resistance to multiple antibiotics occurs in different pathogens and is a growing concern for patient management in Renal Units. Examples of these MDRO include methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *Enterococcus* (VRE), multidrug-resistant gram-negative bacilli (MDR-GNB), carbapenem-resistant Enterobacteriaceae (CRE), carbapenem-resistant *Acinetobacter baumannii* (CRAB), multidrug-resistant tuberculosis (MDR-TB) and *Clostridium difficile*.[125] The prevention of MDRO infections can help improve patient outcomes and reduce overall health-care costs. In this context, the identification of patients colonized with MDRO constitutes the first step to prevent MDRO transmission within a dialysis unit.

Guideline statements

F.1.1. Screening for MDRO is recommended for dialysis patients for the following situation:

1) During an outbreak (defined as ≥2 new isolates of a MDRO identified from clinical specimen and related in time and place);
2) Dialysis patients who have been admitted or received dialysis services within the previous 6 months in an overseas hospital;
3) Dialysis patients who have recently been admitted to a ward/unit where recent MDRO outbreak was suspected or confirmed.

Rationale

Screening should be considered in situations deemed high risk of MDRO transmission.[126,127] These situations include: (i) during an outbreak (defined as ≥2 new isolates of a MDRO identified from clinical specimen and related in time and place); (ii) dialysis patients who have been admitted or received dialysis services within the previous 6 months in an overseas hospital; (iii) dialysis patients who have recently been admitted to a ward/unit where recent MDRO outbreak was suspected or confirmed. Appropriate clinical samples (e.g. wound or nasal swab for MRSA, rectal swabs for VRE and CRE, and urine for MDR-GNR) should be sent for the identification of MDRO. The institution of a screening program should be balanced against effectiveness and the resource implications.

Limitations

There is limited data regarding the optimal and cost-effective strategy for screening MDRO in dialysis patients.

Implementation issues

MDRO surveillance poses significant resource implications on dialysis units. Adherence to screening protocols can be difficult in dialysis units with high patient load and turnover.

Audit measures

Cases of MDRO infection should be properly documented and reviewed periodically. Clustering of MDRO cases should prompt investigation for outbreaks and breach of infection-

control measures. The need for surveillance cultures of MDRO in a dialysis unit should be based on these audit results and changes in local bacteriology.

F2 Management of patients infected or colonized with a MDRO

F2.1 Methicillin resistant *Staphylococcus aureus*

Introduction

In a national survey of dialysis centres in United States, MRSA strains accounts for more than 40% of isolates of *S. aureus.*[128] Risk factors for MRSA infection include diabetes mellitus, advanced age, immunocompromised state and prolonged hospitalization.[129] MRSA is a common pathogen to cause catheter-related complications in dialysis patients and is associated with significant patient morbidity and mortality.[130] In this context, MRSA is a frequent cause of exit-site infection, tunnel tract infection and peritonitis in PD patients. In HD patients, MRSA can cause HD catheter exit-site or tunnel tract infections, bacteremia or even infective endocarditis. The following section reviewed the treatment of MRSA infection among dialysis and advanced chronic kidney disease (CKD) patients. The strategies for screening and decolonization of MRSA will be elaborated in section F5.

Guideline statements

F.2.1.1. Parenteral vancomycin is the treatment of choice for MRSA infection in dialysis patients. (R)

F2.2.2. Daptomycin, linezolid, quinupristin-dalfopristin and tigecycline can be viable alternatives in patients who cannot tolerate vancomycin. (D)

Rationale

Parenteral vancomycin is an established treatment of MRSA infection in dialysis patients. Its clinical efficacy has been demonstrated in the treatment of MRSA exit-site infection, tunnel tract tunnel infection and peritonitis in PD patients.[42] Intravenous vancomycin (at a dose of 1 g every 5–7 days for total of at least 2 weeks) is a recommended treatment of MRSA exit-site or tunnel tract infection in PD patients.[42] Intraperitoneal (IP) vancomycin has been used with success for the treatment of MRSA peritonitis in PD patients. The ISPD guidelines recommended that IP vancomycin be administered for the treatment of PD-related peritonitis due to MRSA.[42] Vancomycin is also effective treatment for HD-catheter related infections including exit-site and CRBI.[131] Other options of MRSA treatment in dialysis patients include teicoplanin, daptomycin, linezolid, tigecycline and quinupristin-dalfopristin. Teicoplanin has the advantage of longer half-life and better tolerability than vancomycin. Daptomycin has been approved for the treatment of complicated MRSA skin infections and bacteremia (with or without endocarditis) in a dosage of 6 mg/kg per day.[132] The dosage should remain the same but the frequency should be reduced to every 48 h in stage 4 or 5 CKD patients.[133] Linezolid (at a dosage of 600 mg twice daily, IV or PO) has been approved for the treatment of MRSA skin infection as well as community- or hospital-acquired MRSA pneumonia.[134] No dosage modification is required for linezolid in dialysis patients but side effects such as thrombocytopenia and lactic acidosis need to be closely monitored.[134] Tigecycline shows good *in vitro* activity against the majority of MRSA strains and is an approved treatment for MRSA skin and intra-abdominal infections.[135,136] One advantage of tigecycline in CKD and dialysis patients is that it does not require dosage adjustment and has little concern regarding its timing of administration in relation to HD due to its poor dialyzability. There is lack of clinical data regarding the use of IP tigecycline for MRSA peritonitis although previous pharmacokinetics studies have demonstrated the stability of tigecycline in different concentrations of PD fluid.[137] Quinupristin-dalfopristin is approved for MRSA skin infections with no dosage adjustment in renal failure subjects but its data in dialysis patients is relatively limited.[133] Other novel treatments for MRSA infections include lipoglycopeptides dalbavancin, telavancin, and oritavancin as well as newer generation cephalosporins such as ceftobiprole and ceftaroline.[135,138,139] The data on these emerging therapies for MRSA, however, is still lacking among renal failure patients and further studies are required to demonstrate their efficacy in such clinical context. Furthermore, some of these agents are still not available in many local centres and hence limiting their clinical utility.

Limitations

There is a steady rise of minimal inhibitory concentration (MIC) for vancomycin over time in *S. aureus* strains.[132] Infections due to MRSA strains with an increased MIC for vancomycin (>1–2 μg/mL) confers escalated mortality risk.[140,141] Vancomycin intermediate *S. aureus* (VISA) are MRSA strains with MIC between 2 and 16 μg/mL and patients infected with VISA are at risk of treatment failure.[142]

Implementation issues

There is limited clinical experience with the use of alternative and novel agents other than vancomycin for MRSA infection in dialysis. Due to its established efficacy and relatively low cost, parenteral vancomycin remains the treatment of choice for MRSA infection in dialysis patients.

Audit measures

The incidence/prevalence and antibiotics susceptibility profile (including MIC) of MRSA infection in a renal unit should be periodically audited. These data will have implications on the screening/decolonization strategies of MRSA as well as the choice of treatment for MRSA infection within the dialysis unit.

F2.2 Vancomycin-resistant enterococcus

Introduction

VRE are strains of *Enterococcus* which showed resistance to vancomycin (defined as MIC ≥32 μg/mL). *E. faecium* and *E. faecalis* account for the majority of VRE isolates. VRE is an escalating threat to the health-care system and outbreaks have been reported in various hospital settings.[143] VRE infections are closely linked to unfavourable clinical outcomes and patient mortality is significantly higher than infections due to vancomycin-susceptible entercoccal isolates.[144]

Guideline statements

F2.2.1. Linezolid is the treatment of choice for VRE infection in renal failure patients. (R)

F2.2.2. Contact precautions, good hand hygiene practices single room isolation or cohorting (if single room is not available) are recommended for patients infected or colonized with VRE. (R)

F2.2.3. Active surveillance cultures can be considered during outbreak or in high-risk patients if the incidence or prevalence of VRE in the facility is not decreasing despite stringent implementation of routine infection control measures. (D)

F2.3.4. Eradication of VRE in patients colonized with VRE is not routinely performed and further investigation is required. (R)

Rationale

Linezolid is an approved treatment for VRE infections and is active against both vancomycin-resistant *E. faecalis* and *E. faecium*, and no dosage modification is required in dialysis patients.[145,146] Clinicians need to be aware of the potential side effects of myelosuppression (e.g. thrombocytopenia) and lactic acidosis with prolonged administration of linezolid. Alternative treatments for VRE infections include daptomycin and tigecycline, but their efficacy is less reliable in VRE bacteremia and higher doses might be warranted.[145,147,148] Quinupristin-dalfopristin can be an alternative for VRE treatment but its indication for endocarditis has been removed recently.[145] As the resistance profile of VRE can be quite variable, clinicians should closely liaise with the microbiologists regarding the optimal choice of antibiotics for VRE infections.

The primary route of VRE transmission is via the hands of health-care professionals, and thus hand hygiene is the most important and practical means of preventing spread of VRE within the hospital.[149] In this context, soap and water as well as alcohol-based hand rubs are both effective and duration of hand washing should be up to 30 s.[150] Contact precautions (i.e. wearing of gloves and gowns during the care of VRE patients) can significantly decrease the VRE acquisition rates.[151,152] Cohorting of VRE patients and/or staff who care for colonized patients can also aid to diminish VRE transmission.[153,154]

Surveillance cultures for VRE can be obtained from rectal or peri-rectal swabs or stool samples.[155] Active surveillance cultures in outbreaks or in high-risk patients can be considered if the incidence or prevalence of VRE in the facility is not decreasing despite stringent implementation of routine infection control measures.[149,156,157] There is currently no effective strategy to eradicate VRE colonization and the efforts to decolonize with oral non-absorbable antibiotics have been disappointing.[155,158]

Limitations

The data and choice for the treatment of VRE in CKD and dialysis patients remain relatively limited. There is current no effective ways to eradicate VRE carriage.

Implementation issues

Compliance to contact precautions and good hand hygiene practice can be difficult in dialysis units with high patient load and turnover. Furthermore, single room isolation or cohorting VRE patients with contact precautions will have significant resource and manpower implications to the unit.

F2.3 ESBL-producing gram-negative bacteria

Introduction

Extended spectrum beta-lactamase-producing Gram-negative bacteria (GNB) frequently cause infections (e.g. UTI, pneumonia or catheter-related infections) among renal failure patients. Infection due to ESBL-producing organisms is a growing problem in dialysis patients and is associated with increased patient mortality.[125,159,160]

Guideline statements

F2.3.1 Carbapenem, with appropriate dosage adjustment, is the treatment of choice for ESBL-producing GNB in renal failure patients. (R)

F2.3.2 Tigecycline can be an alternative treatment for ESBL-producing GNB in renal failure patients who have allergy to β-lactam antibiotics. (D)

Rationale

The use of carbapenem has established clinical benefits on patient survival and bacteriological clearance.[160–162] IP carbapenems have been used with success in PD-related peritonitis due to ESBL-producing organisms.[163,164] Tigecycline can be a viable alternative for the treatment of ESBL-producing organisms, especially in patients with allergy to β-lactam antibiotics.[165] Its relatively low and steady rate of drug resistance is another added merit.[166] Other advantage of tigecycline in CKD and dialysis patients is the little concern for dosage adjustment and the timing of administration in relation to HD.

Limitations

The rising incidence of ESBL-producing GNB is a growing concern in dialysis unit due to its limited therapeutic options and implications on health-care burden for isolation and prevention of transmission. The increased use of carbapenem also poses a risk of carbapenem-resistance.

Implementation issues

The restricted use of cephalosporins can be difficult among dialysis patients who have frequent infections and attendance to health-care services. Adherence to standard precautions with good hand hygiene practice using alcohol-based hand rub can help reduce transmission of ESBL-producing organisms, but can be difficult in dialysis with high patient load and turn-over.

Audit measures

The incidence and antibiotics susceptibility profile of ESBL-producing GNB should be regularly monitored and reviewed. These data should be reflected to the clinicians to facilitate a more scrutinized use of antibiotics (especially cephalosporins). The compliance to infection control practice during the care of patients infected or colonized with ESBL-GNB should also be audited.

F2.4 Multidrug-resistant *Acinetobacter baumannii*

Introduction

Acinetobacter baumannii (*A. baumannii*) has both intrinsic and extrinsic mechanisms to develop resistance to multiple commercially available antibiotics, and multidrug-resistant *A. baumannii* (MRAB) refers to strains which are resistant to all agents in four antibiotics classes (fluoroquinolones, aminoglycosides, cephalosporins, beta-lactam/beta-lactamase combinations).[167] Infection due to resistant strains of *A. baumannii* is associated with higher mortality and hospitalization costs as compared with infections due to susceptible strains.[168,169]

Guideline statements

F2.4.1 Polymyxins (B or E) are the treatment of choice for MRAB in renal failure patients. (R)

F2.4.2 Alternative options of MRAB treatment include minocycline and tigecycline in patients who are intolerant to polymyxins. (D)

F2.4.3. Transmission of MRAB can be reduced by early recognition of MRAB cases, aseptic handling of vascular catheters as well as adherence to hand hygiene and disinfection procedures. (R)

Rationale

There are limited options for the treatment of MRAB and commonly used agents include polymyxins (B or E), minocyclines and tigecycline. Polymyxin B and E (colistin) appeared to have the most extensive clinical data for the treatment of MRAB although the randomized trials addressing their efficacy in MRAB is lacking. The clinical efficacy of polymyxin E had been demonstrated in pneumonia, bacteremia and meningitis caused by MRAB.[170–172] Successful treatment of PD-related peritonitis due to MRAB with IP polymyxin B and ampicillin-sulbactam had also been reported.[173] Clinicians should be aware of the potential nephrotoxicity and neurotoxicity (paraesthesia) when polymyxins are used in CKD or dialysis patients, and appropriate dosage adjustment has to be exercised.[174] Tigecycline have also shown activity against MRAB but there is limited data regarding its use for the treatment of MRAB in renal failure patients.[175,176] Moreover, the use of tigecycline in MRAB was associated with increased mortality when compared with other treatments and thus should only be considered when no other options are available.[177]

Active surveillance, contact isolation, compliance with hand hygiene and aseptic care of vascular catheters are essential measures to control MRAB transmission.[178,179] MRAB remains largely susceptible to disinfectant and antiseptics, and reports of disinfection failure are likely related to failure to follow cleaning procedures rather than emergence of resistance.[180]

Limitations

The data regarding the treatment of MRAB are primarily derived from treatment of other infections in the general population. There is also paucity of data on combination therapy of MRAB, especially in renal failure patients.

Implementation issues

Therapeutic choices for MRAB infections are limited. The need for isolation, prolonged treatment and hospitalization will impose substantial burden to a dialysis unit.

Audit measures

The incidence and antibiotics susceptibility pattern of MRAB in a dialysis unit should be regularly audited and reflected to the clinicians. These data will help assess the effectiveness of the infection-control measures and guide the use of antibiotics in a nephrology unit.

F2.5 *Clostridium difficile*

Introduction

Clostridium difficile (*C. difficile*) is the most common cause of transmissible nosocomial infection in health-care facilities.[181] Renal failure patients are of escalated risk of *C. difficile* infection and hospital-associated morbidity and mortality.[182]

Guideline statements

F2.5.1. The inciting antibiotics should be discontinued as possible. (R)

F2.5.2. Both oral metronidazole and oral vancomycin are effective treatment for mild *C. difficile* infection in renal failure patients. (R)

F2.5.3. Oral vancomycin is the preferred treatment in renal failure patients who suffered from severe *C. difficile* infection. (R)

F2.5.4. Contact precautions and good hand hygiene practices are recommended to prevent *C. difficile* transmission in a dialysis unit. Soap and water is preferred to alcohol-based disinfectant for hand sanitization during an outbreak situation. (R)

Rationale

One key initial step in the management of *C. difficile* infection is the discontinuation of inciting antibiotics.[181,183] Several randomized trials have demonstrated that oral metronidazole and oral vancomycin are equally effective for the treatment of non-severe *C. difficile* infection.[184–186] Oral metronidazole is associated with very low treatment costs, but its use is also associated with higher recurrence rates. Due to its non-absorption in the gastrointestinal tract, oral vancomycin can achieve high local concentration and thus should be used for severe *C. difficile* infection.[181,183] In one prospective randomized double-blind clinical trial, oral vancomycin was shown to be superior to oral metronidazole for the treatment of severe *C. difficile* infection (cure rate 97 *vs* 76%).[184] Contact precautions and hand sanitization (before and after patient care) should be exercised in patients with suspected or confirmed *C. difficile* infection.[181] Soap and water is more preferred than alcohol-based disinfectants to achieve hand hygiene as *C. difficile* spores are resistant to alcohol.[181]

Limitations

Being an anaerobic organism, the culture of *C. difficile* in stool samples can be difficult and the diagnosis often requires the identification of *C. difficile* toxin.

Implementation issues

The discontinuation of inciting antibiotics can be difficult as many dialysis patients require these antibiotics for other concomitant infections and very often the choice of alternative antibiotics is limited. Adherence to contact precautions and hand sanitization can be problematic in nephrology units with high patient load and turnover.

Audit measures

The incidence and treatment outcomes of *C. difficile* infections should be regularly audited. These data will help review current infection control measures in a dialysis facility and guide the choice of antibiotics for the treatment of *C. difficile*.

F3 Other infections (e.g. MDR-TB)

Introduction

While there is established and effective treatment for usual TB infections, there is growing drug resistance to commonly used anti-TB agents.[187] Multidrug-resistant TB is defined as isolates of *M. tuberculosis* that are resistant to at least isoniazid and rifampicin, and has presented significant challenge in patient management due to the limited choice of therapeutic agents and associated treatment toxicities.

Guideline statements

F3.1. Treatment regimen for MDR-TB infection in renal failure patients should comprise fluoroquinolones and injectable aminoglycosides. Aminoglycoside should be used with caution in CKD patients and dialysis patients who still have considerable residual renal function. (R)

F3.2. Other possible options for the treatment of MDR-TB in this locality include linezolid, ethionamide and cycloserine. (D)

F3.3. The infectivity of dialysis patients with suspected or confirmed MDR-TB should be determined by their clinical status, sputum smear and radiographic findings, and appropriate infection control measures should be applied accordingly. (R)

Rationale

A treatment regimen for MDR-TB consists of multiple second-line anti-TB agents which usually includes fluoroquinolones and injectable aminoglycosides.[188] One should be cautious in administering these agents in CKD patients and dialysis patients who still have considerable residual renal function. Other second-line agents include linezolid, ethionamide, cycloserine.[189,190]

The infection precautions of MDR-TB are similar to that of drug-susceptible TB. The infectivity of a MDR-TB patient should be weighed with regarding to their clinical status and sputum smear results.[191] A patient is considered infectious if: (i) they are undergoing cough-inducing procedures; (ii) they have positive sputum smear results for acid fast bacilli; (iii) they have cavitary lesions evident on chest radiography; (iv) they are not receiving adequate anti-TB treatment or show poor clinical response to therapy. Airborne precautions should be strictly exercised in MDR-TB patients with infectivity. In this context, patients should be cared in an isolation ward and dialysis should be performed in areas with appropriate airborne precaution facilities.

Limitations

The data regarding treatment of MDR-TB in dialysis population remains relatively limited. The data concerning novel agents such as bedaquiline and delamanid are lacking in CKD and dialysis patients, and the availability of these agents remain an issue.

Implementation issues

Treatment of MDR-TB remains difficult in CKD and dialysis patients due to limited therapeutic options and increased drug intolerance. The exaggerated side effects in renal

failure patients can contribute to poor drug compliance and frequent modification of drug regimen, and hence increased risk of treatment failure and drug resistance. The need for isolation facilities during patient care and dialysis also impose substantial resource burden to a dialysis unit.

Audit measures

The incidence, sites of involvement and susceptibility pattern of TB infection in the dialysis unit should be periodically monitored. These data will help refine current infection control policy for TB in a dialysis unit.

F4 Management of febrile patients in the dialysis unit

Introduction

Fever in a dialysis patient is frequently related to infections, although other causes such as drug fever, allergic response to components of the HD circuit, deep vein thrombosis, autoimmune diseases or tumour fever are also possible differential diagnoses.[192] A systemic and established protocol of febrile patients in a dialysis unit can improve overall patient outcomes and dialysis unit performance.

Guideline statements

F.4.1 Initially investigations for febrile patients in a dialysis unit should include proper history taking and physical examination, chest radiography and other appropriate microbiological studies including peripheral blood cultures. Clinical samples relevant to the mode of dialysis (e.g. peritoneal fluid cell count and culture in PD patients, blood culture from central catheter in HD patients) should be obtained. (R)

F4.2 Empirical antibiotics should take into consideration the presenting clinical features, underlying medical diseases, spectrum of coverage and previous culture and susceptibility pattern of organisms. (R)

Rationale

Infection remains the most common cause of fever in dialysis patients. The investigation of febrile patients in a dialysis unit should begin with proper history taking and physical examination.[192] The history should include the onset and time course of fever, associated symptoms, travel and contact history, as well as zoonotic and occupational exposures. Special attention should be directed to the dialysis access such as the PD or HD catheter exit sites and AV fistula/graft.[193,194] Initial laboratory investigations include complete blood picture, liver and renal biochemistry, peripheral blood culture, chest radiography and other appropriate microbiological studies (e.g. sputum culture, urine culture, nasopharyngeal aspirate and wound swab cultures). Clinical samples relevant to the patient's mode of dialysis should also be obtained (e.g. peritoneal fluid cell count and culture in PD patients, blood culture from central catheter in HD patients). Serum IgE levels can also be checked if allergy to components of the HD circuit is suspected. Empirical antibiotics should be promptly initiated after appropriate microbiological samples have been obtained. The choice of empirical antibiotics should take into consideration the presenting clinical features, underlying medical diseases, spectrum of coverage, as well as the previous culture and susceptibility pattern of organisms isolated from the patient. For instance, dialysis patients who received immunosuppressive treatments or suffered from neutropenia or septicemia should receive more broad-spectrum IV antibiotics. Unusual pathogens such as atypical organisms, mycobacteria, fungi or MDRO should be considered if patients respond poorly to first-line antibiotics. Removal of PD or HD catheter should be warranted in patients with profound sepsis or poor response to medical therapy.[42] Alternative causes of fever such as drug fever, autoimmune diseases, malignancy or allergy to the components in the HD circuit should also be properly excluded.[192,195–197]

Limitations

There is currently no established guideline on the workup and treatment of febrile patients in dialysis units. The investigation and empirical treatment of febrile patients depends on the clinical presentation, underlying medical diseases, previous culture and susceptibility profiles and local clinicians' experience.

Implementation issues

The high patient variability and the difference in practices among clinicians have contributed to the difficulty in implementation of standard protocols for the management of febrile patients in a dialysis unit.

Audit measures

The incidence/prevalence, type of organism isolated (including susceptibility patterns) and clinical outcomes of febrile patients in a dialysis unit should be regularly reviewed. The data should help refine the current protocol for the management of febrile patients in a dialysis unit.

F5 Management of patients with *staphylococcus aureus* colonization

Introduction

S. aureus is one of the most common pathogens to cause infections in dialysis patients. In this context, both methicillin-sensitive *S. aureus* (MSSA) or MRSA are frequent organisms to cause exit-site and tunnel tract infections as well as peritonitis in PD patients. In HD patients, MSSA and MRSA can cause HD catheter exit-site or tunnel tract infections, bacteremia or even infective endocarditis. Against these backgrounds, the majority of studies have focused on the screening and decolonization of MRSA in dialysis patients with an attempt to reduce MRSA infections and health-care burdens.

F5.1 Screening

Guideline statements

F5.1.1. Active surveillance for MRSA should be considered when there is an established outbreak. (R)

Rationale

The primary objective of *S. aureus* screening programs is to identify at risk patients and perform carrier decolonization to reduce individual risk of infection. Previous studies have addressed the effectiveness of screening and decolonization as part of broader policies to limit the spread of MRSA.[125,149,198–201] Most of these studies employed a quasi-experimental design, with institution of several preventive measures at the same time. While these studies have suggested the effectiveness of screening/decolonization strategies, the positive results might be confounded by publication bias. Recent advances in PCR-based screening have prompted larger and better-designed studies to address this issue and have generated some conflicting results.[199–201] Based on these data, the practice of routine screening for MRSA in dialysis patients remained controversial. However, active surveillance should be undertaken when there is an established outbreak.[126,127]

Limitations

The epidemiology of *S. aureus*, especially MRSA is complex and poorly understood. Screening and decolonization strategies are often implemented as part of a broader infection control program, and thus the individual benefits of screening, contact precaution and decolonization remained unclear.

Implementation issues

Regular surveillance of *S. aureus* carriage has resource and manpower implications. The extent and optimal method of screening remain controversial.

Audit measures

The incidence and prevalence of MRSA carriage and infection should be regularly monitored. A changing incidence/prevalence of MRSA infection should prompt review of the current MRSA screening policy and infection control measures.

F5.2 Decolonization of MRSA carriage

Guideline statements

F5.2.1. Decolonization of MRSA in dialysis patients can be achieved via topical or intra-nasal application of mupirocin alone or in combination with systemic antimicrobial plus an antimicrobial-containing bath. (R)

F5.2.2. Asymptomatic health-care providers who are not epidemiologically linked to MRSA transmission do not require decolonization. (R)

F.5.2.3. Decolonization should be considered in health-care providers who are implicated in MRSA transmission and rendered culture negative before returning to patient care. (D)

Rationale

Pooled data from meta-analysis and multicentre randomized controlled trials have demonstrated the benefits of *S. aureus* (MSSA and MRSA) decolonization in high-risk patients.[35,202] The use of topical combined with systemic decolonization appeared to have higher success rates than topical decolonization alone.[203] Possible decolonization regimens include intra-nasal mupirocin alone or in combination with oral antibiotics (e.g. rifampin in combination with cotrimoxazole or ciprofloxacin or doxycycline) plus the use of an antimicrobial (e.g. chlorhexidine gluconate or povidone iodine) for bathing.[203–205] Decolonization should be considered in health-care providers who are implicated in MRSA transmission and be rendered culture-negative before returning to patient care. However, asymptomatic health-care providers who have not been linked epidemiologically to MRSA transmission do not require decolonization.[126]

Limitations

A successful decolonization program also depends on appropriate screening strategy. The attempts to decolonize MRSA carriers can be limited by recolonization and emergence of resistance to mupirocin or other antimicrobials.[205–207] Furthermore, follow-up surveillance cultures are required to ensure clearance in patients who have received eradication therapy.

Implementation issues

Routine surveillance and decolonization as well as follow-up cultures can impose significant resource and manpower burden to a renal unit.

Audit measures

The effect of the surveillance and decolonization program in a dialysis unit should be periodically reviewed to decide whether further change in policy is needed.

G OUTBREAK INVESTIGATION

G1 Commonly reported outbreaks in renal units and common sources

1. **HBV**: staff carrier, poor infection control, lack of patient and machine segregation, shared multi-dose IV drugs;
2. **HCV**: Ditto;
3. **VRE**: poor infection control, hands of health care worker (HCW) to skin and wounds of patients;
4. **MRSA**: poor infection control, hands of HCW to skin and wounds of patients;
5. **Non-glucose-fermenters** (*Burkholderia* spp, *Ralstonia* spp, *Pseudomonas aeruginosa* and spp, *Stenotrophomonas* spp): bacteraemia due to contaminated water system;
6. **Non-tuberculous mycobacteria** (*Mycobacterium abscessus* and *M. chelonae*): contaminated water system;

7. ***Klebsiella pneumoniae* or *Klebsiella oxytoca* (carbapenemase producing)**: poor disinfection of reprocessed dialyzer; failure of HCW to change gloves between patients;
8. ***Pneumocystis jirovecii***: renal transplant patients not on trimethoprim-sulfamethoxazole prophylaxis;
9. **Nocardia, Aspergillus and other mold infections** in renal transplant recipients: hospital renovation or building work dust;
10. ***Listeria monocytogenes*** in renal transplant patients: unboiled food items;
11. **Tuberculosis**: failure to isolate cases of open TB admitted in the same unit;
12. **Respiratory viruses** (influenza, parainfluenzavirus, respiratory syncytial virus, adenovirus, metapneumovirus, coronaviruses, rhinovirus, enterovirus): failure to isolate the index case in the same unit and poor infection control practice; poor influenza vaccination uptake in patients and HCW in the same unit;
13. **Endotoxin**: water contamination
14. **Chemical contamination** outbreaks of intoxoication (Aluminium seizure/dementia, Chloramine and copper leading to hemolysis, Fluoride and formaldehyde fatality, hydrogen peroxide and anaemia, nitrate leading to methaemoglobinemia, sodium azide and severe hypotension, sulphate leading to fever and gastrointestinal upsets.

G2 Hospital outbreak

An outbreak is defined as an increase in occurrence of an infection above the background rate. It may be one episode of a rare occurrence or many episodes of a common occurrence. In the health-care setting, a hospital outbreak can be practically defined as three or more patients acquiring epidemiologically important agents after 48 h of hospitalization in the same ward. Epidemiologically important agents were classified into four categories: (i) respiratory viruses (influenza A virus, influenza B virus, respiratory syncytial virus, human metapneumovirus, parainfluenza virus, adenovirus and rhinovirus), (ii) gastrointestinal pathogens (norovirus, rotavirus, Clostridium difficile), (iii) MDRO including vancomycin-resistant enterococci, carbapenemase-producing Enterobacteriaceae, multidrug resistant *Acinetobacter baumannii*. Hospital infection control team conducted surveillance, which is an ongoing, systematic collection, analysis and distribution of information regarding the occurrence of an infection in defined populations, to determine an occurrence of outbreak. In addition, frontline health-care workers can inform infection control team for clustering of cases in the clinical units.

G3 How to investigate an outbreak

All health-care workers must be committed to the investigation and implementation of control measures. The steps of carrying out an outbreak investigation are as follows.

G3.1 Case definition

To develop a working case definition based on the known facts of the outbreak. The working case definition must be able to include confirmed and possible cases within a defined time and place. Occasionally, the case definition may need to be refined as the outbreak investigation proceeds and more information is available.

G3.2 Case finding

Once a working case definition is developed, additional case finding can be conducted.

G3.3 Epidemic curve

To describe the outbreak over time, one can plot the number of cases (Y-axis) against time (X-axis) and identify the possible source and mode of transmission of the outbreak. For example, a point source outbreak such as gastrointestinal viral infection usually gives a high peak, followed by continued cases of illness. The epidemic curve of an outbreak due to lapse in infection control practices or contaminated patient equipment usually be spread over a long period, as illustrated in the outbreaks of vancomycin-resistant enterococci, carbapenemase-producing Enterobacteriaceae, multidrug-resistant *Acinetobacter baumannii* in the hospital.

G3.4 Line listing

To obtain the patient demographic and clinical information, one can design a questionnaire for data collection or reviewing medical record. Important such as age, sex, underlying diseases, invasive procedures, presence of catheters, caring clinicians and nurses, exposure to other health-care workers, use of medications and IV fluid. After reviewing the records, one should develop a table containing the data of the patients.

G3.5 Formulation of a hypothesis

Once the epidemic curve and line listing are performed, hypotheses about the possible source of infection and how the infection is transmitted can be generated.

G3.6 Case–control study

To understand the potential risks contributing to the outbreak, case–control analysis can be performed to complete the epidemiological investigation. For example, if 30 affected patients or health-care workers are enrolled, a proportional number (e.g. 30, 60) of unaffected members of the at-risk population should be enrolled as control subjects. Comparison of the exposure to potential risk factors in the patients with that in the control group can be performed by univariate analysis. Since hospital outbreaks usually involve a small number of cases, stratifying the data and multivariate analysis are usually not possible.

G3.7 Microbiological analysis

To confirm the clonal relationship between the outbreak strains, genetic relatedness can be assessed by pulse-field gel electrophoresis, multilocus sequence typing, and recently whole-genome sequencing.

H ANTIMICROBIAL STEWARDSHIP

H1 Introduction

Unnecessary or inappropriate use of antimicrobial agents is the most important cause for the emergence and dissemination MDRO. This has been well demonstrated by the initial emergence of vancomycin-resistant staphylococci, vancomycin-resistant enterococci, extended spectrum beta-lactamase producing- and carbapenemase producing-enterobacteriaceae in renal dialysis patients. The onset of invasive infection by these multidrug-resistant bacteria often starts as asymptomatic colonization of skin and mucosa of renal patients, which is followed by invasive disease at Tenckhoff or HD indwelling vascular devices. Thirty to forty per cent of chronic HD patients receive at least one dose of antimicrobials as outpatient over a 1-year period. In many public hospitals, up to 30% of these antibiotics are prescribed inappropriately according to the improved protection against CMV in transplantation (IMPACT) guidelines.[208–211]

During our daily antibiotic auditing meeting, we find that the most common mistakes include

1. Failure to de-escalate to a more narrow-spectrum antibiotic;
2. The clinical criteria for the diagnosis of an infection such as skin and soft tissue infections are not satisfied;
3. The choice and duration for surgical prophylaxis for vascular-access-related procedures are not following the IMPACT guideline;
4. The most commonly abused antibiotics are vancomycin, and third- or fourth-generation cephalosporins.

Antimicrobial stewardship program is therefore necessary for ensuring:

1. Optimal selection of dose and duration of antimicrobial therapy;
2. Best clinical outcome for the treatment or prevention of infection;
3. Fewest toxic effects and the lowest risk for subsequent resistance.

Antimicrobials have been termed 'societal' drugs because antimicrobial resistance can develop during antimicrobial therapy, any resistant organism that emerges can be spread to persons who have never been exposed to the antimicrobial. Thus, the use and misuse of these resources have 'societal consequences'.

H2 Choice of antimicrobial stewardship strategies

Strategy	Procedure	Personnel	Advantages	Disadvantages
Education guidelines	Creation of guidelines for antimicrobial use.	Antimicrobial committee to create guidelines.	May alter behavioural patterns.	Passive education likely ineffective.
	Group or individual education of clinicians by educators.	Educators (clinical microbiologist, infectious disease physicians).	Avoids loss of prescriber autonomy.	
Formulary restriction	Restrict dispensing of targeted antimicrobials to approved indications.	Antimicrobial committee to create guidelines.	Most direct control over antimicrobial use.	Perceived loss of autonomy for prescribers.
		Approval personnel (clinical microbiologist, infectious disease physicians).	Individual educational opportunities.	Need for all-hours consultant availability.
Review and feedback	Daily review of targeted antimicrobials for appropriateness.	Antimicrobial committee to create guidelines.	Avoids loss of autonomy for prescribers.	Compliance with recommendations voluntary.
	Contact prescribers with recommendations for alternative therapy.	Review personnel (usually clinical pharmacist, infection control nurse (ICN), in Hong Kong).	Individual educational opportunities.	
Computer assistance	Use of information technology to implement previous strategies.	Antimicrobial committee to create rules for computer systems.	Provides patient-specific data where most likely to impact (point of care).	Significant time and resource investment to implement sophisticated systems.
	Expert systems provide patient-specific recommendations at point of care (order entry).	Personnel for approval or review (physicians, pharmacists), computer programmers.	Facilitates other strategies.	
Antimicrobial cycling	Scheduled rotation of antimicrobials used in hospital or unit (e.g. intensive care unit).	Antimicrobial committee to create cycling protocol; personnel to oversee adherence (pharmacist, physicians).	May reduce resistance by changing selective pressure.	Difficult to ensure adherence to cycling protocol Theoretical concerns about effectiveness.

The antimicrobial stewardship program can be functionally classified as:

1. Back-end program (prospective audit with intervention and feedback).
   Antimicrobial use is reviewed after antimicrobial therapy has been initiated and recommendations are made as to their appropriateness in terms of selection, dose, route and duration. For instance, 'big gun' antibiotics (imipenem, meropenem, ertapenem, cefepime, ceftazidime, cefoperazone-sulbactam and piperacillin-tazobactam, glycopeptides (vancomycin, teicoplanin)), tigecycline in Queen Mary Hospital.
2. Front-end programs (prior authorization).
   Antimicrobials are made accessible only through an approval process.

H3 Potential barriers to reaching the strategic goals

Barrier	Counter-measures and improvement strategies
Ownership and accountability	
Lack of ownership and accountability for recognizing and reporting trend.	Designate responsibility and accountability for the process.
Failure to integrate work of laboratory, infection-control, medical, nursing, and care-unit staff.	Set up a multidisciplinary team to develop a collaborative system and monitor results.
Staff knowledge and practice	
Lack of time for the laboratory and/or infection-control staff to generate and analyze data.	Ensure adequacy of laboratory and infection-control staffing and prioritize activities of staff so that data can be generated and analyzed.
Lack of time for health-care providers to examine and discuss data, and inconsistent or erroneous interpretation of data by staff.	Report data in an easy-to-read or interpret format and, when appropriate, include data interpretation in the report.
Physician attitudes	
Lack of trust in the hospital administration.	Use a data-driven approach to cultivate trust, for example, communicate regularly with physicians about trends in antimicrobial usage, cost and resistance, feedback to individual physicians about their performance results
Expertise	
Lack of expertise in biostatistics (e.g. presenting trends and analyzing data).	Ensure availability of consultants, especially when designing analytical strategy and interpreting trend data.

H4 Methods to implement antimicrobial control (back-end programme)

1. Provision of written hospital guidelines.
2. IMPACT guideline is available through: http://www.chp.gov.hk/files/pdf/reducing_bacterial_resistance_with_impact.pdf or App in both iPhone and Android system.
3. Educational efforts aimed at changing prescribing practices of physicians.
4. Providing consultation from clinical microbiologist or infectious diseases specialist.
5. Restriction of hospital formulary through the Drugs and Therapeutics Committee.
6. Utilization review with guidelines for rational and appropriate usage.
7. Ongoing monitoring and analysis of antimicrobial usage.
8. Ongoing surveillance of antimicrobial susceptibility.
9. Monitoring adherence to advice on choice of antimicrobial agents.
10. Feedback to physicians.

H5 Future challenge of antimicrobial stewardship programs in Hong Kong

1. Increasing trend of antimicrobial resistant organisms – emergency of CRE, nosocomial outbreaks of VRE, and increasing prevalence of MRSA in long-term care facilities.
2. Requiring a comprehensive overview of all broad-spectrum antimicrobials agents with epidemiological potential to select antimicrobial resistance, instead of only focusing on a group of selected 'Big gun' antibiotics.
3. Requiring additional resources in terms of manpower and information technology support to enhance the efficiency of workflow.

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Supplement Article

Clinical practice guidelines for the provision of renal service in Hong Kong: Accreditation of Renal Unit

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INTRODUCTION

To date, there are more than 9000 patients on renal replacement therapy in Hong Kong. Among them, there are more than 1600 patients on haemodialysis (HD), and 4000 patients on peritoneal dialysis (PD).

Accreditation of renal dialysis unit should take into account patient safety, staff training and adequacy of facilities to provide quality dialysis for patients.

This section contains guidelines leading to accreditation of a renal dialysis unit.

(Standards are categorized as 'Recommended' and denoted (R) or as 'Desirable' and denoted (D) based on the strength of evidence that such practices will affect the patients' outcome.)

Guideline statement #1: Design and spacing should cater for different needs of a renal unit

1.1 Government building and fire safety regulations should be met. (R)

1.2 Different areas should be provided for patient education, provision of HD and PD services. (D)

1.3 For renal units that provide HD for patients with chronic hepatitis B and hepatitis C infection, designated areas and HD machines should be provided for such patients. (R)

1.4 For renal units that provide HD for patients with potential infectious diseases, designated areas should be available to isolate these patients. (R) If there are patients with same strain of multi-resistant microorganisms, they should be cohorted. (D)

1.5 For centres with home HD service, designated area should be offered for training of home HD. (D)

1.6 Within the PD area, separate rooms are recommended for PD training and care for complications related to PD. (D)

1.7 Contingency guidelines should be in place for suspension of water, electricity supply and fire hazard. (R)

1.8 There should be areas dedicated to storage, clinic area, clean and dirty utility, toilets and staff offices. (D)

Guideline statement #2: There should be qualified staff in renal dialysis unit

2.1 The centre should have qualified nephrologist(s)* and renal nurses. (R)

(Key: *Qualified nephrologist: Name listed in the Medical Council of Hong Kong Nephrology Specialist Registration.)

2.2 Medical doctor should be available for consultation when required. (R)

2.3 Nurse-in-charge should be a registered nurse (general) at the Nursing Council of Hong Kong and has completed a post-registration renal nursing programme. (R)

2.4 Qualified renal nurses should be available during each shift to closely monitor HD procedures. (R)

2.5 Nursing staff is trained either through on-the-job training or a formal structured programme. (R)

2.6 All medical and nursing staff at the renal unit are familiar with resuscitation guidelines and trained to perform cardiopulmonary resuscitation (CPR). (R)

2.7 HD and PD prescriptions should be reviewed by nephrologists regularly. (R)

2.8 For centres with home HD service, qualified renal nurses should be available for training of home HD. There should also be provision of support service, for example telephone consultation, 24-h a day, 7 days a week. (R)

2.9 Qualified renal nurses should be available for training of continuous ambulatory PD (CAPD) and automated PD (APD). (R)

2.10 Channels should be in place for referrals/consultations to other medical specialists, for example surgeons, microbiologists, as well as paramedical personnel, for example dieticians, social workers, physiotherapists. (D)

Guideline statement #3: Water treatment system in the HD unit should be properly installed and maintained

3.1 Installation of a dual water treatment system is preferred. (D)

3.2 The water treatment system should be continuously monitored during patient treatment to ensure proper

functioning. Alarms, either audible or visual, should be fitted within the dialysis treatment area to alert renal unit staff in case performance of the water treatment system drops below specific parameters. (D)

3.3 The operation of the water treatment system for each treatment day should be properly logged and filed. (R)

3.4 Procedure guidelines for disinfection of reverse osmosis machine and loop as recommended by the manufacturer are in place. (R)

3.5 No HD procedure should be performed during disinfection of the water treatment system and the loop. (R)

3.6 The water treatment system components should be regularly maintained (at least once per month) so that bacterial and chemical contaminant levels in the product water do not exceed the standards for haemodialysis water quality. (R)

3.7 Microbiological testing of the product water from the water treatment system and the loop should be done regularly (at least once per month) to ensure standard is maintained. (R)

3.8 Regular testing (at least once per month) of treated water for endotoxin is needed. (R)

3.9 Results of microbiological, endotoxin and chemical testing of treated water should be recorded and reviewed. Corrective action, if indicated, should be recorded. (R)

Guideline statement #4: HD machines should be properly maintained and regularly examined

4.1 Adequate number of unoccupied HD machine should be available on-site as backup. (R)

4.2 Procedure guidelines on preparation of HD machine for HD are in place. The guidelines should be easily accessible. (R)

4.3 Routine disinfection of both active and backup dialysis machines is performed according to defined protocol. For machines using chemical disinfectant, testing for and documentation of absence of residual disinfectants is required. (R)

4.4 Samples of dialysate from HD machines are cultured regularly (at least once per month). (R)

4.5 To ensure quality of dialysis fluid, regular testing for microbiological quality should be performed and documented regularly (at least once per month). (R)

4.6 To ensure quality of dialysis fluid, regular testing (at least once per month) for endotoxin should be performed and documented. (R)

4.7 Testing of inorganic contaminant is desirable. (D)

4.8 Regular testing of dialysate for electrolytes (at least once per month) is desirable to ensure proper function of HD machines. (D)

4.9 Repair, maintenance and microbiological testing results of the HD machines should be properly recorded. Corrective actions, if required, should also be recorded. (R)

Guideline statement #5: Reuse of haemodialysers and related devices should follow proper procedures

Currently, some centres are practicing single-use haemodialysers, while others reuse harmodialysers. This guideline is aimed at centres that are reusing haemodialysers.

5.1 Procedure guidelines for dialyser reprocessing are in place and followed. (R)

5.2 The reprocessed dialyser should be tested for presence of disinfectant before rinsing. Repeat testing for absence of disinfectant should be performed after rinsing. All results should be documented. (R)

5.3 Each dialyser is clearly labelled and identified to be reused by the same patient. (R)

5.4 Reuse of dialyser is not recommended for patients with infections, for example chronic hepatitis B and hepatitis C. (R)

Guideline statement #6: Other equipment in the HD area should be properly maintained

6.1 Emergency equipment and consumables should be easily accessible, and adequate supplies should be ensured. (R) These include:

- Oxygen
- CPR trolley with defibrillator and gel pads, medications used for resuscitation, Ambu bag, equipment for intubation
- Ambu bag and oxygen mask
- Suction equipment
- Electrocardiography machine

6.2 All equipment, including backup equipment, should be operated within manufacturers' specifications. Equipment should be examined regularly. Maintenance should be performed by qualified staff or contract personnel. (R)

6.3 HD unit staff should be trained to identify equipment malfunction, and to report to appropriate staff for immediate repair. (R)

6.4 All records regarding maintenance and repair should be kept on file. (R)

Guideline statement #7: Standards of equipment, solutions and training for PD should comply with international standards

7.1 Fluid for PD should comply with current international quality standards. (R)

7.2 Written protocols for common standard procedures concerning care of PD patients should be in place, reviewed regularly and followed. (R)

7.3 Written procedures and guidelines for training of CAPD and APD and management of complications should be in place, reviewed regularly and followed. (R)

7.4 All APD machines should comply with international standards for electrical and mechanical safety. (R)

Guideline statement #8: Sanitary conditions, hygienic practices and infection control should be maintained with the dialysis unit

8.1 All staff, including doctors, nurses, technical staff and dialysis assistants, should be trained to practise universal precautions. (R)

8.2 All staff should attend infection control refresher training course at least once every 24 months. (R)

8.3 Universal precaution should be practised for all activities involving patient care. (R)

8.4 Hand-washing sinks and alcohol-based hand rub should be readily accessible within patient area to allow hand cleansing before and after each patient care activity. (R)

8.5 Equipment, personal protective equipment and consumables, for example Sharps containers, gloves (both sterile and non-sterile ones), aprons, face masks and goggles should be readily available. (R)

8.6 All staff within the renal unit should have education on management of blood spillage on equipment and the floor. Education material should be readily accessible. (R)

8.7 The environmental surfaces of the renal unit and exterior surfaces of medical equipment should be cleaned and disinfected regularly (at least daily) using 1:99 sodium hypochlorite unless the surface is not compatible with this type of chemical treatment. (R)

8.8 For spillage of blood and other potentially infectious substances, the visible matter should first be cleaned with disposable absorbent material. The spillage area should be cleaned using 1:4 sodium hypochlorite, and left for 10 min. The area should then be rinsed with water. (R)

8.9 There should be a surveillance programme to monitor, review and evaluate the serological status of patients for blood borne viruses. (R)

Guideline statement #9: Other quality assurance activities for patient care should be ensured

9.1 Patients should have regular blood-taking (preferably at least once every 2–3 months) for checking haematology and biochemistry to ensure patients' well-being and to guide modification of dialysis prescription and medications. (R)

9.2 Contingency plans and procedures should be available in case of equipment failure, power cuts or fire to ensure patient's safety and health. (R)

9.3 Drills for CPR and emergency conditions should be performed regularly to ensure staff is well trained in the latest guidelines. (R)

Guideline statement #10: Hong Kong Renal Registry should be updated regularly

This guideline is only for centres that are using the Hong Kong Renal Registry. This includes all renal units within Hospital Authority (HA) and some private hospitals. For patients being followed up by HA, and having HD in private centres, it is the responsibility of staff of HA to ensure the Renal Registry is updated.

10.1 Patients' data should be entered and updated in Renal Registry. (R)

10.2 Mandatory data should preferably be updated within 2 weeks of the event. (R)

10.3 Regular update of data, at least once a year, is recommended. (D)

DISCLOSURE

The authors declare no conflict of interest.

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Supplement Article

Clinical practice guidelines for the provision of renal service in Hong Kong: Use of Registry by Renal Units

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INTRODUCTION

All renal units in Hong Kong need to keep track of their services, in particular, renal replacement therapy, to the patients, which allow peer comparison on service model and provide basis to excel service provision. Databases are developed in collection and utilization of data. To have meaningful comparison, better estimation and reflection on the provision and service scope, and a better representation of patients requiring renal replacement therapy in Hong Kong, a minimum data set is suggested.

DEVELOPMENT OF RENAL REGISTRY IN HOSPITAL AUTHORITY

It is developed in 1995, initially for the allocation of cadaveric kidney for transplantation under agreed rules and calculations. The entry of clinical data enabled the Renal Registry[1,2] to collect other information that is essential for patient management as a clinical summary,[3] the renal unit can use the data for calculation of workload statistics, monitoring of complications and auditing of services provision and clinical parameters. Hospital Authority (HA) Head Office can use the data in planning of future renal services of the whole HA and identify pressure areas, provision of workload statistics and peer comparison of services provision and setting of standards. Data collected can be shared with various stakeholders, including local organization such as NGO, health-care professions and media to facilitate advancement of the health care, by publications[4,5] and other appropriate means; and can generate valuable information through analysis, auditing and research. The data can be shared with international stakeholders periodically or on an ad hoc basis to advance global kidney health. Currently the data is shared with the United States Renal Data System (USRDS)[6] annually, which is published and available freely in the internet.

GUIDELINE STATEMENT ON RECOMMENDATIONS ON DATA ENTRY AND COLLECTION

1	**General**	
1.1	**All data should be updated regularly.**	[R]
Background	To have a better representation of Hong Kong Special Administrative Region (HKSAR) data, it is recommended to have a common data set as agreed by all stakeholders including HA, Charitable organisations, private hospitals, dialysis facilities and clinics, private nephrologists and nursing staff.	
Rationale	A regular, up-to-date data maintenance, at least once yearly is recommended, preferably on 31 December of each calendar year. Units are encouraged to update the data as soon as possible	
1.2	**Data is categorized into mandatory or optional.**	[R]
Rationale	Optional data can be entered at units' own preferences and mandatory data are the core data set required as agreed. Data field in HA Renal Registry (RR) (RR-M02.docx) is attached in appendix for easy reference. There are mandatory items every HA renal unit should enter when enrolling a new patient to renal replacement therapy (RRT) programme in order to ensure annual organ registry and transplant system (ORTS) report to be produced.	
1.2.1	Mandatory data should be entered as soon as possible, and preferably within 2 weeks of event had taken place.	[D]
1.2.2	Each unit should ensure the data update is done at least annually.	[R]
1.2.3	Optional items are to be entered at the discretion of individual renal unit. The more data you enter, the more comprehensive data set can be used in provision of health care.	[D]
2	**Patient**	
2.1	**Demographic data**	
2.1.1	Data to identify the patient including name, unique identification (Hong Kong identity card number or equivalent), sex, age (can be calculated if date of birth is available) as these provides a means to identify individual patient correctly.	[R]

1	**General**	
2.1.2	Patient correspondence address and phone number should be recorded for easy tracking of patients.	[D]
2.2	**Responsible centre**	
	The unit provide primary RRT care should be documented clearly with date of starting and ending.	[R]
Rationale	The information of the unit in provision of renal care is important as centre effect can affect quality and provision of services. Date on claimed and ending of responsible centre of a patient on RRT should be in agreement between the releasing and in-taking units, so that the treatment dates are back to back to enhance data integrity.	
2.3	**Diagnosis**	
	The cause leading to end-stage renal failure (ESRF) and RRT should be entered. This will provide valuable information on the aetiology of renal failure. The categorization is suggested to follow international standard for easy comparison.	[R]
2.4	**Survival status**	
2.4.1	If a patient died, it is important to input the date and cause of death. This can generate important information on the survival pattern and causes of death so that measures can develop accordingly.	[R]
2.4.2	A regular data enquiry with death registry of government and/or HA (PAS) database are suggested for prompt information related to unreported death.	[D]
2.4.3	A categorized cause of death for better comparison between centres and international data is preferred. Centres should make effort in determining the immediate cause of death for meaningful data entry.	[R]
2.5	**Optional patient data**	[D]
Rationale	Centres can feel free to develop and enter data to suit one's clinical need. Optional data sets in HA RR can be referred to appendix. These are not exhaustive and currently include: 1. Other comorbidity 2. Remarks 3. Cancer 4. Non-treatment related infection 5. Rehabilitation status 6. Hospitalization record and text	
3	**Treatment modality**	[R]
Rationale	One of the following as major treatment can be entered – conservative, peritoneal dialysis (PD), haemodialysis (HD) or transplant. Only patients actively on PD, HD or transplant are considered as having long-term RRT. The data should be updated at least once yearly and preferably as soon as possible.	
3.1	**Peritoneal dialysis**	
3.1.1	The date of commencement, ending and cause	[R]
3.1.2	Type of PD (Continuous ambulatory peritoneal dialysis (CAPD) vs automated peritoneal dialysis (APD))	[R]
3.1.3	Connection system	[D]
3.1.4	Payment mode	[D]
3.1.5	Access (Tenckhoff's catheter) creation date	[R]
3.1.6	Dialysis adequacy (*Kt/V*) data	[R]
3.1.7	Exit site infection (as below)	[D]
3.1.8	Peritonitis data	[R]
3.1.8.1	Date	[R]
3.1.8.2	Organism	[R]
3.1.8.3	Antibiotics usage	[D]
3.1.8.4	Outcome (responded, relapsed, failed)	[R]
3.2	**Haemodialysis**	
3.2.1	Treatment Start and End date with cause	[R]
3.2.2	Treatment type (conventional HD vs nocturnal HD, centre based vs home)	[R]
3.2.3	Vascular access (arteriovenous fistula (AVF) vs graft vs catheters – non-cuffed/cuffed)	[R]
3.2.4	Payment method (self vs subsidized – HA, charitable, public private partnership (PPP))	[D]
3.2.5	Dialyzer model	[D]
3.2.6	Dialysate (bicarbonate vs others)	[D]
3.2.7	Duration and frequency of dialysis	[D]
3.2.8	*Kt/V* (standardized vs single pool) to allow comparison as key performance indicator (KPI)	[R]
3.3	**Transplant**	
3.3.1	Before transplant	
3.3.1.1	Patients who are on HA cadaveric renal transplant waiting list should be registered in registry, with arrangement to have blood taken for human leukocyte antigen typing and regular periodic antibody screening performed in transplant and immunogenetics (T&I) in Laboratory in Queen Mary Hospital (QMH)	[R]

1	General	
3.3.1.2	Date of registration is the date commenced on long-term renal replacement therapy	[R]
3.3.1.3	A regular and periodic review on the eligibility on list, with temporary or permanently off list if patient is not suitable to receive transplant	[R]
3.3.1.4	The following are mandatory data should be entered: 1. Hepatitis (B and C) status 2. Blood group 3. Blood transfusion date and number of units 4. Antibody screening 14 days after last blood transfusion	[R]
3.3.2	After transplant	
3.3.2.1	Early transplant registry updating (within a week) to remove name from waiting list	[R]
Rationale	To avoid allocating graft to a 'recently-transplanted' patient	
3.3.2.2	Early transplant data to include following details if available:	
3.3.2.2.1	Donor relationship with patient (cadaveric vs living)	[R]
3.3.2.2.2	Side of kidney to be transplanted	[D]
3.3.2.2.3	Date of transplantation	[R]
3.3.2.2.4	Donor demographic (sex and age, cardiac status on donation)	[D]
3.3.2.2.5	Induction and immunosuppressive drugs	[D]
3.3.2.2.6	Status of kidney transplanted – cold ischaemic time, second warm ischaemic time, days of graft non-functioning	[D]
3.3.2.3	Long-term transplant data	
3.3.2.3.1	Long-term outcome after transplantation (at least yearly)	[D]
3.3.2.3.2	Cause for graft failure and date	[R]
3.3.2.3.3	Complications	
3.3.2.3.3.1	Rejection	[R]
3.3.2.3.3.2	Infection	[D]
3.3.2.3.3.3	Vascular	[D]
3.3.2.3.3.4	Malignancy	[R]
3.3.2.3.3.5	Surgical events (lymphocoele, urinoma, vascular complications)	[D]
3.4	**Optional items** Centres can develop according to clinical need. Other optional data sets in HA RR are attached in appendix for easy reference. These are non-exhaustive and currently include:	[D]
3.4.1	Conservative (dialysis not necessary vs palliative)	
3.4.2	Erythrocyte stimulating agent – type and dose per month	
3.4.3	Blood transfusion (date and number of units)	
3.4.3.1	on transplant waiting list	[R]
3.4.3.2	not on transplant waiting list	
3.4.4	Growth hormone	
Rationale	All the optional items are up to individual units, except if the patient is actively on transplant waiting list, the entry of blood transfusion amount and date is mandatory to, arrange schedule to check antibody sensitization and development for facilitation of organ allocation (see section Transplant).	
4	**Potential Use of Renal Registry Data** Units are encouraged to utilize the data collected to help generating data and information important to improve service provision. This can include, but not exhaustive of, the followings:	
4.1	**Growth of the RRT population**	[D]
Rationale	This includes the number and ratios of patients on each kind of RRT, including peritoneal dialysis (PD), haemodialysis (HD) and Transplants (living/cadaveric) modalities and their characteristics (age, sex and adequacy).	
4.2	**Patients on transplant waiting list**	[R]
Rationale	Regular updating and review on the suitability to remain on transplant waiting list with prompt communication with T&I to optimize resources utilization.	
4.3	**Audit cycles and KPI**	[D]
Rationale	Centres can use the data for meaningful peer comparison of KPI and find ways for continuous quality improvements (CQI). References can be made to other sections in this guideline on the various recommendations.	
4.4	**Sharing of data to improve service provision to HK and internationally**	[D]
Rationale	This includes, but not exhaustive of, data retrieval for CQI and audit purpose, data uploading to international sites for comparison between HK and the rest of the World, and in the promotion of global renal health.	

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