

# ISPD GUIDELINES/RECOMMENDATIONS

## RECOMMENDED PERITONEAL DIALYSIS CURRICULUM FOR NEPHROLOGY TRAINEES

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In early 1999, the new International Society for Peritoneal Dialysis (ISPD) Council, under the leadership of Dr. Ram Gokal, proposed that the Society’s Subcommittee on Standards and Education should draw up a recommended curriculum outlining what nephrology trainees should know about peritoneal dialysis (PD). The Subcommittee comprised six members from five different countries on three continents. Over a period of 6 months, a draft document was developed and brought to the October 1999 ISPD Council meeting. Members of council and other individuals reviewed the document and gave feedback that led to alterations. A final version of the curriculum was presented to the ISPD Council meeting in San Francisco in February 2000 and was approved as an official recommendation of the Society.

This document outlines, in more detail than has previously been the case (1), the desired body of knowledge that nephrology trainees should have. It is recognized that this body of knowledge may vary somewhat from country to country depending on the extent of PD use in that region and also on local prac-

tices. One particular example of this is the issue of whether trainees need to learn how to place a PD catheter. In some regions, this continues to be a necessary skill for a nephrologist, whereas in others it is performed almost exclusively by surgeons. The final draft of the syllabus allows for such variation. It is the plan of the ISPD to distribute this syllabus widely, and particularly to bodies involved in accreditation of nephrology training in various countries and regions. It is hoped that this document will lead to a wider knowledge of the fundamentals of PD and thus ensure better practice of the modality and, ultimately, better outcomes for PD patients.

### ANATOMY AND PHYSIOLOGY OF PD

The nephrology trainee should be able to

1. Describe the gross anatomy of the peritoneal membrane, including its vascular supply and lymphatic drainage, as well as the microscopic anatomy and relative disposition of the mesothelium, interstitium, and peritoneal capillaries;
2. Understand the basic principles underlying peritoneal transport, including knowledge of the relative tissue resistances to peritoneal transport and an awareness of the three-pore theory and the distributed model of peritoneal transport;
3. Discuss the three components of peritoneal trans-

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Received 3 July 2000; accepted 6 July 2000.

port (i.e., diffusion, ultrafiltration, and fluid absorption), the factors that influence them, and how they might be modified to alter clearance and fluid removal, including also a basic knowledge of how these transport functions are measured and how they might be assessed clinically [e.g., mass transport area coefficient, peritoneal equilibration test (PET)];

4. Understand the PET, how it is carried out, potential problems associated with its performance, interpretation of its results (D/P values for urea, creatinine, and sodium; D/D<sub>0</sub> values for glucose; and net ultrafiltration), and the implications of high and low transport status and the associated risks for the patient. Trainees in pediatric nephrology should understand how the PET is carried out in children, with particular reference to the choice of dwell volume;
5. Describe the constituents of commercially available solutions for PD and how these might be altered to influence peritoneal transport (e.g., dialysate sodium level, alternative osmotic agents), and have an awareness of the concept of “sodium sieving” at the peritoneal membrane; and
6. Understand the relationship between body surface area and peritoneal surface area as the rationale for standardizing peritoneal dwell volumes by body surface area, if the trainee is studying pediatric nephrology.

#### PERITONEAL DIALYSIS MODALITIES, THEIR INDICATIONS, AND ASSOCIATED TECHNOLOGY

The nephrology trainee should be able to

1. Describe the differences, advantages, and disadvantages of the various PD modalities [continuous ambulatory peritoneal dialysis (CAPD), automated peritoneal dialysis (APD) with/without day dwells] and the potential indications for these modalities, including their advantages and disadvantages with reference to clearances, ultrafiltration, cost, and effect on lifestyle, and have a knowledge of the principles underlying tidal PD, its advantages and disadvantages in terms of clearance, discomfort on drainage, cost, etc., and indications for its use;
2. Understand the assessment of peritoneal transport properties by the PET and how the results influence PD modality selection (CAPD vs APD, long versus short day dwells, etc); and
3. Understand the technology and equipment associated with delivery of different modalities of PD, and have a knowledge of dialysis solution composition and volume of solution bags available (2 L, 2.5 L, 3 L, 5 L, etc.); transfer sets (straight-line

vs Y-set vs double-bag systems); adaptor/extension tubing; PD catheters, and the advantages and disadvantages of single-cuff versus double-cuff models, standard versus Swan neck catheters, and straight versus coiled versus otherwise modified catheter tips; the types of cyclers and night exchange devices available and their potential advantages and disadvantages, and the assist devices available to help in making connections between tubing and solution bags, and between tubing and catheter. Pediatric nephrology trainees should particularly understand the pediatric applications of these technologies and appreciate the associated limitations (e.g., substantial recirculation when some systems are used in infants).

#### CLEARANCES ON PD

The nephrology trainee should understand

1. The indices used to assess adequacy of clearances on PD (Kt/V urea and normalized creatinine clearance) and how both the peritoneal and residual renal components of these are measured in PD patients, and have an awareness of potential errors in the measurement of these indices, the reasons for discrepancy between them, and an appreciation of the methods used and problems associated with normalizing these indices to body size;
2. The concepts of target clearances for PD patients, the recommended values for them, and the underlying rationale and associated controversies (i.e., relative contributions of residual renal function and PD to total clearance); the results of major studies (e.g., the CANUSA Study) investigating the association between clearances and patient outcomes; the differences between intermittent and continuous clearance, in particular with reference to the greater efficiency of the latter in removing solute; and the hypotheses to appreciate the difference between them (i.e., peak concentration hypothesis, importance of urea rebound);
3. The factors determining clearance in CAPD and how they might be altered to increase delivered clearances (i.e., increasing dwell volumes, increasing frequency of exchanges, increasing ultrafiltration); the relative advantages and disadvantages of these factors in clinical and economic terms, and how they should be applied in the context of the patient's social and clinical circumstances;
4. The factors determining clearance in APD regimens and be aware of how these factors might be altered to increase delivered clearances (e.g., ad-

dition of day dwells, alteration of cycler dwell volumes, number of cycles), and appreciate the relative advantages and disadvantages of altering these factors in clinical and economic terms, and their effect on patient lifestyle;

5. The importance of residual renal function in PD patients, with particular reference to its better preservation on PD relative to hemodialysis, and to its strong power for predicting clinical outcomes in PD patients, and possible explanations for these findings;
6. How commercially available computer programs can be used to calculate PD clearance and model PD prescriptions, and the advantages and disadvantages of such modeling; and
7. The clearance indications for initiation of PD and how they might be applied, and the concept of “incremental” versus “maximal” or “full-dose” PD.

#### ULTRAFILTRATION AND MANAGEMENT OF FLUID OVERLOAD

The nephrology trainee should

1. Understand how the basic principles underlying peritoneal transport apply to fluid removal by PD, with particular reference to factors affecting ultrafiltration and peritoneal fluid absorption (including lymphatic flow), and how these might be altered in clinical practice; have an in-depth knowledge of the effect of the osmotic agent used (i.e., glucose or polyglucose) on the quantity of ultrafiltration achieved;
2. Know the current standardized approaches for evaluation of peritoneal fluid removal (i.e., PET) and factors that might affect the accuracy of this test;
3. Have an understanding of the concepts of “target” or “dry” weight and clinical fluid overload in PD patients, and know the differential diagnosis for fluid overload, the appropriate diagnostic approaches, and the therapeutic options available;
4. Understand the difference between fluid overload due to ultrafiltration failure and that due to other causes (i.e., noncompliance, mechanical problems, inappropriate choice of solutions, excess salt and fluid intake);
5. Have an in-depth understanding of the evaluation of actual ultrafiltration failure, including knowledge of its classification and the physiology underlying the various causes, as well as the diagnostic approach and therapeutic options for each of them; and
6. Be aware of the natural history of peritoneal membrane function with time on PD and its potential effect on ultrafiltration.

#### PERITONITIS AND EXIT-SITE INFECTION

The nephrology trainee should be aware of

1. The criteria for the diagnosis of exit-site infection, tunnel infection, and peritonitis in PD patients;
2. Potential routes by which peritonitis is acquired, their relative importance, the common etiologic organisms (including *Staphylococcus epidermidis*, *Staphylococcus aureus*, *Enterococcus*, *Pseudomonas*, other gram-negative organisms, fungi, and mycobacteria), and the associated risk factors for these infections and their significance in terms of patient outcome;
3. The importance of dialysis set tubing configuration (also known as “connectology”) (e.g., straight-line systems, Y-sets, double bags) as a determinant of peritonitis rate; this should include an appreciation of the effect alterations in the systems have had in reducing peritonitis rates and the mechanisms that may be responsible for this (“flush before fill,” etc.);
4. Common etiologic organisms for exit-site infections and the associated risk factors for them, with particular reference to *Staphylococcus aureus* and the role of nasal carriage of this organism and its treatment with anti-infective agents; the common strategies for exit-site management and the implications of exit-site infection for clinical outcome in terms of peritonitis, catheter loss, etc;
5. The management of exit-site infection, with both local and systemic measures, and recommendations made on this topic by the ISPD;
6. The management of peritonitis and have knowledge of the typical antibiotic sensitivities of common etiologic organisms, dosing schedules for commonly used antibiotics, intraperitoneally, orally, and intravenously where relevant, and their associated side effects, and ISPD recommendations for treatment of peritonitis; and have an understanding of indications for catheter removal and subsequent reinsertion, and an awareness of the importance of detecting peritonitis secondary to intra-abdominal pathology (e.g., diverticulitis); and
7. The complications of peritonitis, including increased dialysate protein losses, nutritional compromise, loss of ultrafiltration capacity, damage to the peritoneal membrane, etc.

#### MECHANICAL COMPLICATIONS

The nephrology trainee should know

1. The catheter-related mechanical complications associated with PD (malpositioned catheter, en-

- trapped catheter, catheter-associated leaks, etc.) and have a detailed knowledge of the management of a nonfunctioning catheter (role of radiologic evaluation, laxatives, anticoagulant and fibrinolytic agents, catheter manipulation, laparoscopy, etc), and an understanding of the clinical presentations for these catheter-related complications, the diagnostic evaluation (office and radiologic), and the therapeutic options (both nonsurgical and surgical) to correct them; and
2. The mechanical complications associated with PD that are anatomic in nature [i.e., peritoneal leaks (subcutaneous, peritoneal-pleural, or hydrothorax) and hernias] and have a knowledge of the differential diagnosis of genital swelling in these patients, and an understanding of the clinical presentation for all these disorders and their diagnostic evaluation, office and radiologic, and therapeutic options, both nonsurgical and surgical.

#### MANAGEMENT OF NUTRITIONAL STATUS

The nephrology trainee should

1. Be aware of the indices commonly used in clinical practice to assess nutritional status [normalized protein equivalent of nitrogen appearance (nPNA), serum albumin, subjective global assessment, lean body mass by creatinine excretion, anthropometric measurements (e.g., skinfold thickness)], and have a knowledge of how these indices are measured and what problems may be associated with their measurement and use. Pediatric nephrology trainees should be aware of the particular importance of growth in the assessment of nutritional status in children on dialysis;
2. Be aware of the predictive power of indices of nutritional status for predicting outcomes including death, hospitalization, and technique failure in PD patients;
3. Know the appropriate dietary targets for PD patients, with particular reference to protein intake, caloric intake, and vitamin and other mineral requirements, and have a knowledge of how total energy intake (dietary intake plus peritoneal glucose absorption) can be estimated, and be aware of how dietary protein intake can be assessed using nutritional records or measured nitrogen excretion; have a knowledge of some of the formulas used to estimate nPNA, and potential problems with them, including the issue of appropriate normalization. Pediatric nephrology trainees should be aware of the particular dietary targets for children on PD and the formulas used to estimate nPNA in this population;

4. Understand the various etiologies of malnutrition in PD patients, with special reference to issues such as inadequate clearances, acidosis, comorbidity, inflammation, dialysate protein losses, growth hormone resistance, dialysate glucose absorption, dialysate-induced visceral compression, etc.;
5. Be aware of the factors influencing serum albumin in PD patients, with particular reference to peritoneal transport status, dialysate protein losses, and indices of inflammation (e.g., C-reactive protein); and
6. Be aware of potential strategies for treatment of malnutrition, with particular reference to correction of inadequate clearances, treatment of comorbidity, correction of acidosis, the role of oral nutritional supplements, enteral supplements via nasogastric tube or gastrostomy, intraperitoneal amino acids, and anabolic agents (e.g., anabolic steroids, recombinant growth hormone). Pediatric nephrology trainees should understand the particular role of recombinant growth hormone in the treatment of growth retardation in children on PD.

#### PERITONEAL DIALYSIS SOLUTIONS AND BIOCOMPATIBILITY

The nephrology trainee should

1. Be able to describe the basic composition of PD solution and the intended role of the individual components during dialysis;
2. Understand the biology of the peritoneal mesothelium and the first-line defense mechanisms against infection during PD;
3. Understand the unphysiologic nature of current PD solutions (low pH, hypertonicity) and their potentially harmful effects on PD defense mechanisms and the mesothelium;
4. Understand the issues related to the use of lactate as a buffer in PD patients and the potential issues associated with its replacement by bicarbonate as a buffer;
5. Have an awareness of newly available PD solutions, such as intraperitoneal amino acids and polyglucose preparations, and the indication for their use;
6. Be able to describe some of the potential toxicities associated with the use of glucose as an osmotic agent, with particular reference to the potential deleterious effects of glycosylation and of hypertonic solutions on the peritoneum, and also of the potential adverse effects associated with glucose degradation products and other derivatives produced during solution manufacturing; and

7. Understand the potential advantages and disadvantages of altering the concentrations of sodium and calcium in PD solution.

#### HEMATOLOGIC, ELECTROLYTIC, AND METABOLIC COMPLICATIONS OF PD

The nephrology trainee should be aware of

1. The causes of anemia in PD patients (erythropoietin deficiency, iron deficiency, infection, inflammation, etc.) and its significance as a predictor of adverse clinical outcomes;
2. The management of anemia in PD patients, with particular reference to indications for the use of erythropoietin, recommended targets for hemoglobin/hematocrit, indices used to assess iron status (ferritin, transferrin saturation, etc.); and iron deficiency (oral and parenteral iron), the associated risks, and how they should be managed;
3. The causes of hypernatremia, hyponatremia, hyperkalemia, hypokalemia, acidosis, and alkalosis in the PD patient and how they should be managed;
4. The management of hyperglycemia in CAPD and APD patients with attention to the role of diet, PD solution tonicity, oral hypoglycemic agents, and insulin; this should also include knowledge of the advantages and disadvantages of intraperitoneal insulin and how a switch from subcutaneous to intraperitoneal dosing should be managed;
5. Divalent ion metabolism, including the advantages and disadvantages of low versus high calcium formulations of PD solutions, choice of phosphate binders, indications for use of vitamin D, and monitoring of clinical indices (alkaline phosphatase, parathyroid hormone assays);
6. The different types of renal bone disease, including renal osteodystrophy, adynamic bone disease, and osteomalacia; indications for bone biopsy and parathyroidectomy, and management of PD patients post parathyroidectomy; and
7. The prevalence of abnormalities of serum lipids and lipid metabolism in PD patients, their possible etiology, significance, and how they might be managed, with particular reference to knowledge of the risks and benefits associated with commonly used lipid-lowering drugs.

#### ACUTE PD

The nephrology trainee should

1. Know the indications/contraindications as well as the advantages and disadvantages of acute PD compared to other forms of acute dialysis (i.e.,

hemodialysis and other continuous renal replacement therapies) in the management of acute renal failure, toxic/metabolic, electrolyte, or volume problems in critically ill patients;

2. Be familiar with the technique for acute PD catheter placement— to be actually able to insert a catheter is a desirable skill and will be essential in some settings but not necessary at all in others, and so this is left to the discretion of individual training programs;
3. Know how to prescribe acute PD in management of acute renal failure and toxic/metabolic, electrolyte, and volume problems in critically ill patients;
4. Know how to monitor patients on acute PD (i.e., fluid balance, electrolytes, glucose, etc.);
5. Know the complications associated with acute PD (i.e., catheter-related, abdominal distention, peritonitis, hypotension, hyperglycemia, electrolyte disorders, and hypoalbuminemia) and how to manage them; and
6. Be familiar with the use of automated cyclers in acute PD.

#### CARDIOVASCULAR DISEASE IN PD

The nephrology trainee should understand

1. The high prevalence and incidence of cardiovascular disease in the dialysis population and how it is generally a significant predictor of clinical outcome;
2. The possible risk factors for cardiovascular disease in the dialysis population, with particular reference to the importance of classic (hypertension, hyperlipidemia, diabetes, smoking) and renal failure-related (anemia, malnutrition, inflammation, etc.) risk factors;
3. Management strategies to modify risk factors favorably in PD patients, with particular reference to management of hypertension, hyperglycemia, and hyperlipidemia; and
4. Medical and surgical treatment strategies for cardiovascular disease and have an up-to-date awareness of potential risks and benefits in the treatment of ischemic heart disease, left ventricular hypertrophy, hyperlipidemia, hypertension, and congestive heart failure, and how these might operate in the renal failure population.

#### TRANSPLANTATION IN THE PD PATIENT

The nephrology trainee should be aware of

1. The importance of transplantation as a treatment option in PD patients;
2. Eligibility criteria for transplantation in these

patients, with particular reference to appropriate medical assessment, including diagnosis and management of relevant comorbid medical conditions such as cardiovascular disease and infection; and

3. The interaction between PD and transplantation, with particular reference to immediate pre- and postoperative patient management, the risks of delayed graft function in PD compared to hemodialysis patients, and the management of posttransplant exit-site infections and peritonitis.

#### DELIVERY OF PD IN PEDIATRIC AND GERIATRIC POPULATIONS

The nephrology trainee should appreciate

1. The particular issues, both medical and social, that arise when PD is applied in the pediatric population, and have a knowledge of principles of antibiotic prescription, modality selection, and dialysis prescription, and also an awareness of guidelines for vaccination in this population; and
2. The particular issues, both medical and social, that arise when PD is used to treat elderly patients and how these issues might influence choice of technology and prescription determination in this population.

#### THE ECONOMICS OF PD

The nephrology trainee should be aware of

1. How to assess the costs of the various PD modalities in a given setting, and the costs associated with medical caregivers (physicians, nurses, etc.), solutions, tubing, cyclers and assist devices, hospitalization rates, training, etc., and how costs are influenced by alterations in the PD prescription and how they compare with the costs for hemodialysis in the same setting;
2. The funding mechanisms for provision of PD in the jurisdiction(s) in which the trainee intends to practice, how this compares with funding for hemodialysis in the same setting, and how all this might potentially influence modality selection, prescription of PD, and patient outcome; and
3. The approximate costs and funding mechanisms for other treatments PD patients might require, such as erythropoietin, other commonly used medications, and nutritional supplements.

#### REFERENCE

1. Coles GA, Uttley L. Training in peritoneal dialysis. *Perit Dial Int* 1994; 14:115-16.