Saudi clinical guidelines for peritoneal dialysis 2014 I SAUDI CLINICAL GUIDELINES FOR PERITONEAL DIALYSIS 2014 Council of Health Services

Chapter · January 2014

DOI: 10.13140/2.1.4172.5125

CITATIONS
0

READS
1,568

1 author:

Jameela Kari
King Abdulaziz University and International Medial Center
204 PUBLICATIONS **3,893** CITATIONS

SEE PROFILE

SAUDI CLINICAL GUIDELINES FOR PERITONEAL DIALYSIS

2014

Council of Health Services

TABLE OF CONTENTS :

MEDICAL ABBREVIATIONS

ACEIs	Angiotensin Converting-Enzyme Inhibitors
AKI	Acute Kidney Injury
APD	Automated Peritoneal Dialysis
ARBs	Angiotensin Receptor Blockers
BMI	Body Mass Index
BP	Blood Pressure
BSA	Body Surface Area
BUN	Blood Urea Nitrogen
CAPD	Continuous Ambulatory Peritoneal Dialysis
Ccr	Creatinine clearance in liters
CKD	Chronic kidney Disease
CQI	Continuous Quality Improvement
CT	Computed Tomography
DEI	Dietary Energy Intake
D / P	Dialysate : Plasma
DPI	Dietary Protein Intake
DRI	Dietary Reference Intake
EER	Estimated Energy Requirements
eGFR	estimated Glomerular Filtration Rate
ERBP	European Renal Best Practice
ES	Exit Site
ESI	Exit Site Infection
ESRD	End –Stage Renal Disease
ESP	Encapsulated Sclerosing Peritonitis
GDP	Glucose Degradation Products
GFR	Glomerular Filtration Rate
HD	Hemodialysis
IP	Intra-Peritoneal
IPP	Intra-Peritoneal Pressure
ISPD	International Society of Peritoneal Dialysis
ISRNM	International Society of Renal Nutrition and Metabolism
KDIGO	Kidney Disease Improving Global Outcomes
KDOQI	Kidney Disease Outcomes Quality Initiative (***THE NATIONAL KIDNEY FOUNDATION***)
KUB – X ray	Kidney, Urinary tract , Bladder – X ray

MAMC	Mid-Arm Muscle Circumference
MDH	Maximum Duration of Haemodialysis
MRI	Magnetic Resonance Imaging
MRSA	Methicillin-Resistant Staphylococcus Aureus
NICE guidance	National Institute for Health and Care Excellence guidance
NIPD	Nocturnal intermittent peritoneal dialysis
NSAIDs	Non-Steroidal Anti-Inflammatory Drugs
PCR	Protein Catabolic Rate
PD	Peritoneal Dialysis
PDF	Peritoneal Dialysate Fluid
PET	Peritoneal Equilibration Test
PEW	Protein Energy Wasting
PNA	Protein equivalent of total Nitrogen Appearance
PRSL	Potential Renal Solute Load
QI	Quality improvement
RCT evidence	The Randomized Controlled Trial evidence
RRF	Residual renal function
RRT	Renal replacement Therapy
SDS	Standard Deviation Score
SEP	Sclerosing Encapsulating Peritonitis
SGA	Subjective Global Assessment
SIGN	International Sign Association
TI	Tunnel Infection
UF	Ultra-Filtration
UFF	Ultra-Filtration Failure
UF volume	Urine fluid volume
WBC	White Blood Corpuscles

CONTRIBUTING AUTHORS

ABDULLAH ALHWIESH ,MD
Professor of internal Medicine and Nephrology ,Dammam University,Dammam,Saudi Arabia

ABDULLAH AL ZULFAH,MD
Consultant Pediatric Nephrologist , King Abdulaziz Medical city, Riyadh,Saudi Arabia

ABDULKAREEM AL-SUWAIDA,MD
Consultant Nephrologist , King Saud University ,Riyadh ,Saudi Arabia

ABDULHADI ALTALHI,MD
consultant pediatric nephrologist ,King Saud medical city,Riyadh,Saudi Arabia

ADNAN ALFI ,MD
Consultant Nephrologist ,Ministry of health, Jeddah ,Saudi Arabia

AQEEL ALGHAMDI,MD
Consultant Pediatric Nephrologist ,Ministry of health ,Saudi Arabia

AYMAN KARKAR ,MD
Consultant Nephrologist, Ministry of health, Dammam,Saudi Arabia

JAMEELA KARI,MD
Professor of Pediatrics, Consultant pediatric Nephrologist, King abdulaziz University, Jeddah, Saudi Arabia

KHALID ALHASAN,MD
Consultant Pediatric Nephrologist , King Saud University ,Riyadh ,Saudi Arabia

LUTFI ALKORBI , MD
Consultant Nephrologist,King Faisal Specialist Hospital, Riyadh ,Saudi Arabia

MAJED ALOUFI ,MD
Consultant pediatric Nephrologist, Prince Sultan Medical Military city, Riyadh ,Saudi Arabia

MOHAMMED AL MAGHRABI,MD
Consultant pediatric Nephrologist,King Fahad Specialist Hospital,Dammam,Saudi Arabia

MOHAMMED ALSUNAID,MD
Consultant Nephrologist,King Faisal Specialist Hospital, Riyadh ,Saudi Arabia

PREFACE

This clinical reference is intended for health care professionals who are managing peritoneal dialysis patients. It is a small book that summaries up to date peritoneal dialysis clinical guidelines for both adults and pediatrics.
The organization of the book reflects coverage of contents to the clinical aspects.
Part 1 provides up to date clinical guidelines for management of adult peritoneal dialysis.
Part 2 focuses on clinical guidelines for pediatric peritoneal dialysis while part 3 outlines major peritoneal dialysis unit setting and standards.

guidelines objectives:

- To uniform the standard of care for patients on peritoneal dialysis nationwide.
- To establish quality care measures in peritoneal dialysis management for health care providers nationwide.
- To provide summary of recommendations in different clinical aspects for peritoneal dialysis patients serving as quick guide for healthcare giver.

guidelines scope:

- Summary of recommendations in different clinical aspects for peritoneal dialysis management. detailed rationales and literatures review topics are excluded
- Clinical guidelines for both adult and pediatric patients.
- Core guidelines related to PD .clinical aspects like anemia, cardiovascular diseases and bone diseases are excluded
- Outline of major PD unit setting standards. Detailed unit space specifications are excluded
- providing suggested reading in each chapter rather than detailed references helping toward more concise guidelines .

guidelines developer:

The developer of this guidelines is the national program of renal diseases , council of health services in Saudi Arabia.

How these guidelines were developed:

These are adopted clinical guidelines from best up to date available clinical evidence in the field of peritoneal dialysis management which have been developed through tow assigned committee groups (adult and pediatric) compose of senior nephrologists from various health sectors in Saudi Arabia.

INTRODUCTION

Peritoneal dialysis (PD), hemodialysis (HD) and kidney transplantation constitute an integral renal replacement therapy program, where end-stage renal disease (ESRD) patients can be shifted to one or more of these treatment modalities according to their assessment and prescription and/or when one of these modalities fails to satisfy its needs. Peritoneal dialysis has been well established as a first choice renal replacement therapy (RRT) modality with higher survival rate, especially in the first few years of treating ESRD patients. Peritoneal dialysis, and in particular when there are no contraindications, can be an excellent initial choice and first treatment option.

Recent studies have shown that when compared to HD, PD is associated with equivalent or better survival especially among non-diabetic and younger diabetic patients, where PD has an equal or lower mortality rate during the first 1-2 years of therapy. In addition, PD has the benefits of preserving residual renal function, delaying the need for vascular access and helping patients with multiple vascular access failure, a better option for older age groups especially those with cardiovascular disease and in promoting self-care and helping patients who are in need of more freedom. In fact, PD has become an attractive modality of renal replacement therapy following the recent availability of new PD solutions such as icodextrin and amino-acid-based and biocompatible PD fluids. The advance in PD technology, and in particular the better connecting systems with significant reduction in peritonitis rate and the improved technology of new generation of automated cycler dialysis machines enhanced PD utilization. Studies from the United Kingdom and more recent studies from Netherlands, Belgium and New Haven study have documented that if patients are given informed choice of dialysis treatment, 40-60% will choose PD modality. In addition, when comparing patient satisfaction with modality of HD versus PD as in CHOICE study, patients on PD therapy were more satisfied. Furthermore, patients on PD modality from New Haven study were not only more satisfied with their care, but they also felt with less significant impact of PD on their lives. Finally, one of the advances of PD has been the introduction of automated peritoneal dialysis (APD) technique and compact easy to use cyclers with many advantages.

Despite the multiple benefits and advantages, there has been a slow progress or decline in PD utilization in several countries. The major reasons include (1) insufficient or lack of focus on patients' education and training and encouragement and support, especially for anxious and unwell patients who might be nervous about participating in their own treatment, (2) lack or inadequate training of nursing staff and nephrologists in PD therapy, (3) insufficient encouragement and support of medical and nursing staff to guide patients to chose or implement PD modality as a possible first choice therapy, (4) lack or insufficient appreciation of the concept of "integrated renal replacement therapy (RRT) program", and (5) inadequate preparation or lack of a proper set up of an independent PD unit.

The success and continuity of a PD program relies on different factors including enthusiasm and commitment of the PD team, continuous training program for medical and nursing staff, structured educational program for pre-dialysis chronic kidney disease (CKD) patients, application of continuously updated policies and procedures and continuous evaluation and assessment of the applied program. Actually, implementation of these major steps should not only lay the foundation for solid PD program, but also should help in providing and maintaining adequate and unified standard technical PD performance and successful continuity of the program. This approach should be reflected on extended patient's PD treatment years, as an initial option of RRT, preservation of residual renal function, better preparation of kidney transplantation, delaying or avoidance of HD with vascular access problems, enjoying social life and more freedom together with least technical, infectious and non-infectious complications.

PART 1
ADULT PERITONEAL DIALYSIS CLINICAL GUIDELINES

CHAPTER 1 GUIDELINES FOR ADEQUACY OF PERITONEAL DIALYSIS

GUIDELINE (1) : ADEQUACY OF PERITONEAL DIALYSIS

1.1 Adequacy of peritoneal dialysis (PD) should be a concept and not a number and should include clinical assessment of laboratory results, peritoneal and renal clearances, hydration status, appetite and nutritional status, energy level, quality of life, hemoglobin concentration, responsiveness to erythropoietin therapy, electrolytes and acid–base balance, calcium phosphate homeostasis, and blood pressure control.

GUIDELINE (2) : RESIDUAL RENAL FUNCTION

2.1 Frequency of measurement:

2.1.1 Residual renal function (RRF), which represents the function of the native kidneys or the in situ kidney allograft, should be measured at initiation of PD therapy and then every 2 months in the first 6 months, then the measurement to be every 4 months.

2.1.2 More frequent measurement at the following times:

2.1.2.1 Patients who rely significantly on residual renal function to achieve the minimal target level of small solute clearance, RRF should be monitored regularly and at an appropriate frequency (every 1 – 2 months)

2.1.2.2 Substantial decline in urine output.

2.1.2.3 Unexplained fluid overload.

2.1.2.4 With major change of clinical status (eg, hospitalization or weight loss) or biochemical evidence of worsening uremia.

2.1.2.5 Within 4 weeks of any alteration in PD prescription.

2.2 Measures of RRF should be estimated by using 24-hour urine collection and should also be expressed as glomerular filtration rate (GFR) in milliliters per minute .

2.3 RRF should be considered insignificant if urine volume in a 24-hour collection period is ≤ 100 mL or GFR < 2ml/min.

2.4 Preservation of RRF

2.4.1 Health care team in every dialysis facility should strive to preserve RRF.

BP should be controlled to less than 140/90 mmHg provided that this is not associated with signs and symptoms of postural hypotension or volume depletion.

2.4.3 Angiotensin converting-enzyme inhibitors (ACEIs) or angiotensin receptor blockers (ARBs) should be strongly considered, unless contraindicated, in all PD patients with significant urine output.

2.4.4 Strong consideration should be given to the use of high-dose oral furosemide (up to 250 mg bd) and oral metolazone (up to 5 mg bd) in all PD patients with significant (>100 mL daily) urine output, provided that this is not associated with signs and symptoms of postural hypotension or volume depletion.

2.4.5 Avoidance of potential insults to residual renal function which include avoidance the use of nephrotoxic drugs like aminoglycosides and NSAIDs, avoidance or judicious use of radiographic contrast dye, prevention of episodes of hypotension and volume depletion, and finally prevention and proper control of hypercalcemia and proteinuria.

GUIDELINE (3) : PERITONEAL MEMBRANE TRANSPORT CHARACTERISTICS

3.1 Peritoneal membrane transport characteristics should be monitored for all PD patients using peritoneal equilibration test (PET).

3.1.1 Standard PET is the traditional test used for assessment of peritoneal membrane transport characteristics. It is standardized both procedurally and interpretably.

3.1.2 Fast PET is a simplified standard PET test which is easier, practical and faster and can be used as screening tool to evaluate changes in peritoneal membrane functions in patients that have previously undergone standard PET.

3.1.3 Modified PET is performed to evaluate ultrafiltration failure.

3.2 Baseline peritoneal membrane transport characteristics should be established 4 weeks after initiating a daily PD therapy but no earlier, and to be repeated routinely every 6-12 months.

3.3 More frequent monitoring should be done if clinically indicated:

3.3.1 Presence of unexplained volume overload.

3.3.2 Decreasing drain volume in overnight dwell in CAPD and in daytime dwell in APD.

3.3.3 Increasing clinical need of hypertonic dialysate dwells to maintain drain volume.

3.3.4 Worsening hypertension.

3.3.5 Change in measured peritoneal solute removal (Kt/V_{urea}).

3.3.6 Unexplained signs and symptoms of uremia.

3.4 All measurements of peritoneal transport characteristics should be obtained when the patient is clinically stable and at least 1 month after resolution of an episode of peritonitis.

3.5 Icodextrin should not be used in the preceding exchange before a PET as it increases the dialysate:plasma (D/P) creatinine ratio.

3.6 PD patients should be categorized according to their peritoneal membrane transport characteristics and PD modality and prescription to be modified accordingly.

GUIDELINE (4) : MEASURES OF PD DOSE AND SOLUTE CLEARANCE

4.1 Delivered PD dose and small solute clearances in peritoneal dialysis should be measured by total weekly Kt/V_{urea} and total weekly creatinine clearance:

4.1.1 Total (peritoneal plus renal) weekly Kt/V_{urea} which defined as urea clearances [Kt, (L/week)] normalized to total body water [V, (L)], is based on a 24-hour collection of urine (kidney Kt/V_{urea}; if urine volume >100 mL/day) and a 24-hour collection of effluent for PD including the ultrafiltration with the infused dialysate volume (peritoneal Kt/V_{urea}).

4.1.2 Total (peritoneal plus renal) weekly creatinine clearance in liters (Ccr) normalized to 1.73 m^2 body surface area (BSA), is based on 24-hour collection of urine (if urine volume > 100ml/day) and estimation of the average of urea and creatinine clearance (renal C_{Cr}) and 24-hour collection of effluent for PD including the ultrafiltration with the infused dialysate volume (peritoneal C_{Cr}).

GUIDELINE (5) : FREQUENCY OF MEASUREMENT OF DELIVERED PD DOSE AND TOTAL SOLUTE CLEARANCE

5.1 Within the first six months of PD initiation

5.1.1 Total weekly Kt/V_{urea} and total weekly C_{Cr} measurement should be measured one month after PD initiation and a every 3-4 months subsequently.

5.1.2 Measurements should not be performed sooner than 2 weeks of PD initiation.

5.2 More frequent measurements at the following times

5.2.1 With major change of clinical status (eg, hospitalization or weight loss) or biochemical evidence of worsening uremia.

5.2.2 Within 4 weeks of any alteration in PD prescription.

5.2.3 After 4 weeks of resolution of peritonitis.

5.3 Routine measurements of total Kt/Vurea and total creatinine clearance should be performed when the patient is clinically stable (eg, stable weight, BUN and creatinine concentrations).

5.4 Baseline total Kt/V_{urea} and total C_{Cr} should be established from the first 2-3 measurements.

GUIDELINE (6) :METHODS OF MEASUREMENT OF DELIVERED DOSE OF PD

6.1 Accurate measurement of total Kt/V_{urea} and total creatinine clearance (C_{Cr}) requires accurate collection and analysis of urine, dialysate, and serum in a way that yields reproducible and valid results.

6.2 Compliance with complete urine and dialysate collections is mandatory.

6.3 Serum sample preferred to be obtained according to modality:

6.3.1 For CAPD patients, the serum sample can be obtained at any convenient time.

6.3.2 For APD patients, the serum sample should be obtained at the midpoint of the daytime dwell or the midpoint of daytime empty period if patient on NIPD.

6.4 Total body water (V) should be estimated by either the Watson or Hume method in adults using actual body weight.

6.5 Body surface area (BSA) should be estimated by the DuBois and DuBois method, the Gehan and George method, or the Haycock method using actual body weight.

6.6 In malnutritioned patient the total body water and the BSA should be estimated based on his or her Ideal Body Weight.

GUIDELINE (7) : TARGETS FOR SOLUTE CLEARANCE

7.1 Adequacy targets for dialysis should include both solute removal and fluid removal.

7.2 Total (renal and peritoneal) weekly Kt/V_{urea} of 1.7 or a Total (renal and peritoneal) weekly creatinine clearance of 50L/1.73m^2 should be considered as minimal delivered dose.

7.3 The minimum peritoneal target for Kt/V_{urea} in anuric patients is a weekly value of 1.7.

7.4 The minimum peritoneal target for net ultrafiltration in anuric patients is 750 ml./day.

7.5 In APD patients, due to a more variable relationship between urea and creatinine clearance, an additional target of 45 L/week/1.73 m^2 for creatinine clearance is recommended.

GUIDELINE (8) : FAILURE TO ACHIEVE PRESCRIBED PD DOSE

8.1 Patient related causes of failure to achieve prescribed PD dose should be identified and corrected with special consideration to incompliance of patients to prescribed dose, lack of understanding of importance of adherence to full prescription and errors of sampling and collection.

8.2 Staff related causes of failure to achieve prescribed PD dose should be identified and corrected with special consideration to errors in patient selection, errors in prescription, inadequate monitoring of delivered dose and inadequate patient education.

8.3 Estimation of total daily creatinine excretion in urine and dialysate that differs from the baseline rate (as determined during the first 6 months by >15% should prompt an investigation for noncompliance, improper collection of drained dialysate and/or urine, or altered peritoneal transport function.

GUIDELINE (9) : PERITONEAL DIALYSIS PRESCRIPTION

9.1 The peritoneal dialysis prescription should take into consideration patient's body surface area (BSA), peritoneal membrane permeability properties, and amount of RRF.Also the patient's schedule and quality of life should be taken into account.

9.2 For continuous ambulatory PD (CAPD), the usual starting prescription need not to exceed daily 4 exchanges of 2 liters fill volume. Lower volumes or fewer exchanges than 4×2 L daily can be used for smaller individuals or for those with significant RRF.

9.3 For automated peritoneal dialysis (APD), the initial prescription should be 3-5 cycler exchanges of 2 liters fill volume and the time on the cycler should range between 7 to 10 h. Lower fill volumes than 2 liters can be used for smaller individuals or for those with significant RRF.

9.4 PD prescription should be modified subsequently according to clinical status of the patients and periodic assessment of membrane characteristics and solute adequacy tests.

9.5 To optimize middle-molecule clearance in patients who have minimal RRF, the PD prescription should preferentially include dwells for the majority of the 24-hour day. This is recommended even if small molecule clearance is above target without the longer dwell.

9.6 To optimize small-solute clearance, the instilled fill volume per exchange should first be increased before increasing the number of exchanges per day. The exchange volume of the supine exchange(s) should be increased first because this position has the lowest intra- abdominal pressure.

9.7 Anuric patients should not be offered less than 24-h dialysis.

9.8 To optimize the fill volume, the PD prescription should be personalized taking into account the following key points

9.8.1 Body surface area; the classic fill volume of 2 liter per exchange in standard adult person can be expressed as 1200ml/m2 and should be beneficial in patients with small BSA. The optimal fill volume in an adult is 1400-1600mL/m2.

9.8.2 Intraperitoneal pressure (IPP); an increase in fill volume of 500 mL (increasing IPP by 1 cmH2O in supine position) increases the net fluid absorption rate by about 35 mL per hour.

9.9 Compliance of the patients with prescriptions must be verified periodically.

9.10 The patient's record of PD effluent volume should be reviewed monthly, with particular attention to the drain volume from the overnight dwell(s) of CAPD and the daytime dwell(s) of APD.

GUIDELINE (10) : MAINTENANCE OF EUVOLEMIA

10.1 All PD patients should have established dry weight within the first 30 days of PD initiation, and should be monitored regularly for consistent achievement of this dry weight and volume status every 1-3 months or more frequently according to clinical stability.

10.2 Net daily peritoneal UF volume of <750 mL in anuric patients or <250 mL in patients with RRF should be an indication for careful evaluation of volume status focusing on salt and water intake, blood glucose control in diabetic patients, cardiac status, changes in RRF, appropriateness and adherence to the PD prescription, mechanical complications and change in peritoneal membrane function.

10.3 If membrane failure is suspected, assessment with a modified (4.25% dextrose) PET is warranted. A peritoneal UF volume of less than 400 mL over 4 hours with a 4.25% dextrose PET is a good indicator of UF failure, after excluding other causes eg,Leak or Catheter Dysfunctions.

10.4 Management of hypervolemia

10.4.1 Sodium intake should be restricted to 65 mmol (1500 mg) or less daily in patients with hypervolemia.

10.4.2 In patients with RRF, high-dose diuretics (furosemide 250 mg twice daily(bd) with or without metolazone 5 mg bd increase sodium excretion and urine volume.

10.4.3 Hypertonic 4.25% dextrose solution may be required to achieve euvolemia; however, sustained use of such solution is not desirable.

10.4.4 Icodextrin solution is preferred over glucose-based dialysate for long-duration (>8-hour) dwells.

10.4.5 PD regimens resulting in fluid reabsorption should be avoided. Patients with high or high average solute transport, at greatest risk of this problem, should be considered for APD and icodextrin.

10.4.6 Anuric patients who consistently achieve a daily ultrafiltration of less than 750 ml should be closely monitored and the benefits of modality switch should be considered.

10.5 Management of hypertension

10.5.1 Patients with hypertension should be assessed for hypervolemia and, if appropriate, treated as outlined in the guideline "10.4 management of hypervolemia".

10.5.2 Target BP should be <140/90 mmHg.

10.5.3 ACEIs or ARBs should be the preferred antihypertensive agents; however, comorbid conditions should be taken into account when prescribing antihypertensive.

GUIDELINE (11) : NUTRITION IN PD

Nutritional support is an essential part for achieving target adequacy .full recommendations as per related chapter page

GUIDELINE (12) : QUALITY IMPROVEMENT PROGRAMS

12.1 Each PD facility should establish quality improvement programs with the goal of monitoring clinical outcomes and implementing programs that result in improvements in patient care.

12.2 Quality improvement programs should include representatives of all disciplines involved in the care of the PD patient, including physicians, midlevel practitioners, nurses, social workers, dietitians, and administrators.

12.3 Quality improvement (QI) domains that should be considered include the rates of peritonitis, exit site infection, technique failure, patient satisfaction, quality of life, catheter related problems and catheter survival. QI domains should be broadened to include standard therapeutic targets of adequacy measures, blood pressure and volume control, anemia and bone mineral metabolism management, lipid control, etc.

CHAPTER 2 GUIDELINES FOR PERITONEAL DIALYSIS SOLUTIONS

GUIDELINE (1) : OSMOTIC AGENTS OF PERITONEAL DIALYSIS (PD) SOLUTIONS

1.1 Glucose is the standard osmotic agent for PD solutions. The lowest glucose concentration possible to achieve euvolemia should be used.

1.2 Amino acid-containing solution should be considered in malnourished patients to improve nutritional status. Amino acid solutions should only be administered once daily(4–6 h dwell) to avoid uremic symptoms and metabolic acidosis.

1.3 Poly-glucose solution which is commercially available as icodextrin 7.5%, containing glucose polymers and having an average molecular weight of 16200 Da, can be safely and effectively substituted for glucose-based dialysates in one long-dwell peritoneal dialysis exchange per day (up to 16 hours).

1.3.1 Icodextrin should be specifically considered in patients with symptomatic fluid overload and ultrafiltration failure, particularly in the settings of acute peritonitis, high transport characteristics, and diabetes mellitus.

1.3.2 Whenever possible, early and continued use of icodextrin should be considered.

1.3.3 With the use of icodextrin, the patients should be closely monitored for skin rashes, hyponatremia and accumulation of maltose and other saccharides which interfere with biochemical assays (e.g. glucose, amylase).

GUIDELINE (2) : BUFFER SYSTEM OF PD SOLUTIONS

2.1 Biocompatible PD solutions buffered with either lactate, bicarbonate or both and delivered in multi-chamber bag should be the first choice of PD solution.

2.2 Although, lactate is the standard buffer applied in conventional PD solution but lactate containing PD solution is bioincompatible and all normal cellular functions of resident peritoneal cells are impaired.

2.3 High buffer-containing solution should be used in patients with metabolic acidosis (venous serum bicarbonate <25mmol/1). However, the serum bicarbonate concentration should be monitored in order toavoid metabolic alkalosis (venous serum bicarbonate>29mmol/l).

GUIDELINE (3) : ELECTROLYTE CONSTITUENTS OF PD SOLUTIONS

3.1 Commercially available PD solutions contain132-134 mEq/L(mmol/L) of sodium. PD solutions containing 115-126 mmol/l of sodium have shown promising results.

3.2 Potassium should not be included in PD solution.

3.3 Commercially available PD solutions contain1–1.75mmol/1 of calcium. Low calcium-containing solutions should be used in patients with hypercalcaemia. However, the serum calcium concentration should be monitored in order to avoid hypocalcaemia.

3.4 Commercially available PD solutions contain0.25–0.75mmol/1 of magnesium. Low magnesium-containing solutions should be used in patients with hypoparathyroidism.

GUIDELINE (4) : WARMING OF PD SOLUTIONS

4.1 PD solutions should be warmed prior to inflow and should be used as soon as possible following heating.

4.2 Any of the following dry heating methods (heating pads, heating/warming cupboards, or manufacturer-supplied warming devices) can be used to warm PD solutions prior to infusion.

4.3 Measured solution temperature prior to inflow should be approximately 37 degrees C (+/- 0.5 degrees C). Solution temperature can be checked by folding the bag over an electronic thermometer probe.

4.4 Water baths should not be used for heating solutions due to the potential of water borne organism contamination to the system.

4.5 PD solution should appear clear in colour prior to infusion and the bag should be discarded if the solution appears brown following exposure to the heat source.

4.6 All staff, patients and caregivers should receive specialized training that is aimed at mitigating potential risk factors associated with warming of PD solutions such as hot spots and glucose degradation products (GDP) formation.

ADEQUACY OF PERITONEAL DIALYSIS SUGGESTED READINGS:

1. Agrawal A. &Nolph K.D. Management of high peritoneal transporters. Peritoneal DialysisInternational 20: 160-165, 2000.

2. Blake PG, Bargman JM, Brimble KS, Davison SN, Hirsch D, McCormick BB, Suri RS, Taylor P, Zalunardo N, Tonelli M; Canadian Society of Nephrology Work Group on Adequacy of Peritoneal Dialysis: Clinical Practice Guidelines and Recommendations on Peritoneal Dialysis Adequacy 2011. Perit Dial Int 31: 218–239, 2011.

3. Daugirdas JT, Blake PG, Ing TS, Eds.: Handbook of Dialysis. 4th ed. New York, Lippincott Williams & Wilkins, 2006.

4. Dombros N, et al. European best practice guidelines for peritoneal dialysis. 8 Nutrition in peritoneal dialysis. Nephrol. Dial. Transplant. 2005;20(Suppl. 9):ix28–ix33.

5. Fischbach M, Stefanidis CJ, Watson AR, European Paediatric Peritoneal Dialysis Working Group (2002) Guidelines by an ad hoc European committee on adequacy of the paediatric peritoneal dialysis prescription. Nephrol Dial Transplant 17:380–385.

6. Fouque D, Vennegoor M, ter Wee P et al. EPBG guideline on nutrition. Nephrol Dial Transplant 2007; 22(Suppl 2): ii45–ii87.

7. Han SH, Han DS (2012) Nutrition in patients on peritoneal dialysis. Nat Rev Nephrol 8: 163–175. doi: 10.1038/nrneph.2012.12.

8. Johnson D, Brown F, Lammi H, Walker R, Caring for Australians with Renal Impairment (CARI). The CARI guidelines. Dialysis adequacy (PD) guidelines. Nephrology (Carlton) 2005; 10 (Suppl 4): S81–S107.

9. Kathuria P, Twardowski ZJ. Automated Peritoneal Diálisis. En: Khanna R, Krediet RT, Eds. Nolph and Gokal`s Textbook of Peritoneal Diálisis, third edition. Springer Science 2009.

10. National Kidney Foundation. KDOQI Clinical Practice Guidelines and Clinical Practice Recommendations for 2006 Updates: Hemodialysis Adequacy, Peritoneal Dialysis Adequacy and Vascular Access. Am J Kidney Dis 48:S1-S322, 2006 (suppl 1).

11. National Kidney Foundation: II. NKF-K/DOQI clinical practice guidelines for peritoneal dialysis adequacy: Update 2000. Am JKidney Dis 37[Suppl 1]: S65–S136, 2001.

12. Rees L, Feather S, Shroff R. Peritoneal dialysis clinical practice guidelines for children and adolescents. http://www.bapn.org/assets/clinical_standards/BAPN%20PD%20Standards%20and%20Guidelines.pdf. Accepted January 2008

13. Woodrow G, Davies S. Clinical Practice Guidelines: Peritoneal Dialysis. UK Renal Association, 5th Edition, 30 July 2010. www.renal.org/guidelines.

PD SOLUTIONS GUIDELINES SUGGESTED READINGS:

1. BC renal agency, peritoneal dialysis guidelines: Warming of peritoneal dialysis solution. http://www.bcrenalagency.ca/sites/default/files/documents/files/Warming%20Peritoneal%20Dialysis%20Solutions.pdf.

2. Chaudhary K and Khanna R.Biocompatible Peritoneal Dialysis Solutions:Do We Have One?Clin J Am SocNephrol. 2010 Apr;5(4):723-32. doi: 10.2215/CJN.05720809. Epub 2010 Jan 21.

3. Dombros N, Dratwa M, Feriani M, et al; EBPG Expert Group on Peritoneal Dialysis: European best practice guidelines for peritoneal dialysis. 5 Peritoneal dialysis solutions. Nephrol Dial Transplant. 2005 Dec;20Suppl 9:ix16-ix20.

4. Johnson DW, Agar J, Collins J, et al: Recommendations for the use of icodextrin in peritoneal dialysis patients. Nephrology (Carlton). 2003 Feb;8(1):1-7.

5. Schmitt CP, Bakkaloglu SA, Klaus G, Schröder C, Fischbach M; European Pediatric Dialysis Working Group.Solutions for peritoneal dialysis in children recommendations by the European Pediatric DialysisWorking Group. PediatrNephrol. 2011 Jul;26(7):1137-47. doi: 10.1007/s00467-011-1863-4. Epub 2011 Mar 31.

6. Schröder C.H. on behalf of the European Paediatric Peritoneal Dialysis Working Group: The Choice Of Dialysis Solutions In Pediatric Chronic Peritoneal Dialysis: Guidelines By An Ad Hoc European Committee. Perit Dial Int., Vol. 21, pp. 568–574.

7. Teitelbaum I and Burkart J. Peritoneal Dialysis. Am J Kidney Dis. 2003 Nov;42(5):1082-96. Review.

CHAPTER 3 PD CATHETER RELATED CARE AND STANDARDS INADULT

GUIDELINE (1) THE ACCESS TEAM
GUIDELINE (2) TIMING AND COORDINATION OF REFERRAL AND SURGERY
GUIDELINE (3) IMPLANTATION PROTOCOL
GUIDELINE (4) THE IMPLANTATION TECHNIQUE
GUIDELINE (5) FACILITIES FOR PD CATHETER INSERTION
GUIDELINE (6) TRAINING FOR PD CATHETER INSERTION
GUIDELINE (7) AUDIT OF PD CATHETER INSERTION

The main function of a peritoneal dialysis catheter is to permit consistent bidirectional flow of dialysate without extraordinary effort or undue discomfort [1]. The catheter's function depends upon its design, implantation site, and the configuration of the system used to perform dialysis exchanges.Most catheters are flexible tubes with multiple ports in the distal (intraabdominal) segment which is ideally positioned freely in the intraabdominal pelvic area. The catheter's midportion is normally implanted within the wall of the abdomen via one to two Dacron velour cuffs. With double-cuffed catheters, the deep cuff is imbedded in the abdominal rectus muscle; the superficial cuff in both double cuff and single cuff catheters is placed subcutaneously approximately 2 cm from the catheter exit site on the abdominal wall.

TYPES OF CATHETERS

Many types of catheters are available for chronic peritoneal dialysis . The double cuff straight Tenckhoff catheter, a silicone catheter with a straight (as opposed to coiled) intra-abdominal portion is a commonly used catheter [1-3]. The Missouri Swan Neck catheter and the Toronto Western catheter have also been used extensively [4]. Regardless of type, overall catheter survival is approximately 88 percent at one year with removal rates of 15 percent per year [3,5,6].The benefit of one catheter over another has not been conclusively demonstrated by prospective, randomized trials [3,5-9]. A systematic review published in 2004, for example, found no difference related to prevention of peritonitis with respect to straight versus coiled or single versus doubled cuffed catheters, although all cause mortality may be lower with straight catheters (RR of 0.26, 95% CI of 0.07 to 0.99) [7].

A randomized prospective study of 132 patients found no difference in time to catheter malposition, catheter-associated infections, or overall catheter survival [10]. However, an unexplained finding on secondary outcome analysis in this study was that a significantly decreased time to technique failure was observed with the coiled catheter (1.4 versus 2.1 years). This was principally due to inadequate small-solute clearance. However, the authors report no difference in dialysis adequacy measures between the two groups, suggesting that study bias is responsible for the observed differenc

CONSIDERATIONS IN CATHETER PLACEMENT :

Various factors require consideration when inserting a peritoneal dialysis catheter. These include the location of the exit site, use of prophylactic antibiotics, implantation technique, pre- and postoperative care of the catheter, and temporal needs for dialysis [19].Exit site location — Most PD catheters are placed in a paramedian or lateral abdominal location rather than in the midline. This location allows for positioning of the catheter's deep cuff in or below the rectus muscle, thereby permitting better tissue ingrowth around the cuff due to the richer vascularization of muscle tissue. A paramedian location also provides better structural support for and a strong seal around the catheter, thereby minimizing the risk of peritoneal leak [1-3]. The incidence of peritonitis or exit-site/tunnel infections appears to be similar with midline or lateral insertions. Gentle dissection and careful exit-site construction resulting in the smallest possible hole for the exiting catheter is therefore desirable.

Sutures should never be placed at the catheter exit site. Suture material may act as a nidus for bacterial growth and increase the risk of catheter-related infection. Fibroblast ingrowth of the Dacron cuff is sufficient to anchor the catheter.

There is a paucity of data relating to the efficacy of prophylactic antibiotics before PD catheter implantation. The administration of an antibiotic just prior to peritoneal catheter placement may decrease the incidence of wound infection and peritonitis [24-29].In the largest prospective study, 221 patients undergoing PD catheter placement were randomly assigned to vancomycin (1 gm given intravenously 12 hours prior to the procedure), cefazolin (1 gm given intravenously 3 hours prior to placement), or no antibiotics [28]. At two weeks, the incidence of peritonitis was significantly lower in those given antibiotics, particularly vancomycin (1, 7, and 12 percent for the vancomycin, cefazolin, and no treatment groups, respectivelyfor suture material at the exit site.In a systematic review published in 2004, an analysis of four randomized prospective studies consisting of 335 patients (including the study just mentioned) found that the use of perioperative intravenous antibiotics, compared with no treatment, significantly reduced the risk of peritonitis within one month of surgery (RR of 0.35, 95% CI 0.15 to 0.80)

There are reports of a rise in the incidence of vancomycin resistant Enterococcus sp. As a result, the routine use of vancomycin for prophylaxis prior to catheter insertion is not recommended. Other antibiotics, such as a cephalosporin, should therefore be the first choice [30].

Implantation technique

Compared with an upwardly or horizontally-directed PD catheter tunnel, a downwardly-directed tunnel is preferred and recommended by International Guidelines since it may be associated with fewer catheter infections and fewer peritonitis episodes resulting from catheter or tunnel infections [17]. Catheters with a permanent bend (eg, Swan Neck catheter) naturally have a downwardly-directed tunnel because of the catheter's configuration .There are several basic methods of PD catheter insertion [1-3,20,32]

1- Percutaneous catheter insertion using seldinger
2- Percutaneous catheter insertion technique (simple, new and safe technique by dr alhwiesh with help of introducer and guide wire)(32)
3- Laparoscopy technique
4- Fluoroscopy technique

5- Surgery technique either by a standard dissection or by a modification, such as the buried technique (Moncrief-Popovich) or using a presternally-located catheter

Percutaneous catheter insertion represents a bedside intervention predominantly performed by nephrologists. It requires only local anesthesia, sedation, and minimal transcutaneous access. Insertion of the PD catheter by the nephrologist has therefore been encouraged by several studies.[32] The ultimate goal is to provide timely and effective catheter insertion without an unduly long wait time or delay, during which potential candidates for PD may lose interest in the modality.

Several worldwide reports have suggested that insertion of PD catheters by nephrologists from centers with more experience in PD results in more effective control of infectious complications and peritoneal access creation (27,30.32). The practice of PD catheter insertion by nephrologists substantially contributed to better treatment outcomes.

Peritoneoscopy/laparoscopy — Peritoneoscopic catheter placement permits immediate use and, in experienced hands, is a relatively simple and quick procedure [3]. At one center, a significantly lower incidence of flow dysfunction was observed with such placement (particularly advanced laparoscopic techniques) compared with an open surgical procedure

Fluoroscopy — Percutaneous fluoroscopy-guided placement provides accurate placement with little waiting time and a relatively small incision . Limited data suggest that this approach provides similar outcomes compared with more invasive techniques . however, the incidence of late leakage appears to be increased.

Surgery — Surgical placement of catheters has the advantage of precise catheter placement with little risk of viscus perforation. Disadvantages are the longer time involved (including operating room scheduling), greater cost, and larger incision required.

The buried catheter technique differs from the standard surgical technique in that the entire catheter remains buried subcutaneously until it is ready to be used, usually four to six weeks after catheter placement [25]. At that time, the catheter is exteriorized. This method was developed to possibly reduce peritonitis and catheter infections by allowing complete sinus tract healing and fibroblast ingrowth into the cuff before local trauma to the exit site could occur.

Summary :

As with the choice of catheter, the technique used by a PD program depends upon the preferences and expertise of the surgeon or nephrologist inserting the catheter. Each method of insertion has its benefits and proponents, but no technique has been shown to be preferable overall [13]. A survey of surgical residency program directors showed that, although most programs included peritoneal dialysis catheter placement as a procedure taught to their trainees, most surgeons placed two or fewer than five catheters during their training [26]. Thus, experience in individual programs will dictate the technique and operators placing PD catheters

POSTOPERATIVE CATHETER CARE :

Newly placed catheters are usually flushed with small volumes of dialysate (heparin may be added as 500 to 1000 units/L dialysate if fibrin or clots are evident) until the effluent is clear. The catheter is then capped and a dressing applied to the site.There are few controlled trials of optimal catheter care post-placement, but most suggest that the catheter site be covered with gauze dressing and remain undisturbed for several days [3]. The catheter should be immobilized with a dressing and/or tape to minimize trauma [3]. Infrequent dressing changes (eg, once/week) are probably sufficient for the first one to two weeks after implantation.It is important to minimize catheter movement and handling, since local trauma can increase the risk of bacterial colonization with subsequent infection. However, limited data suggest that if necessary, the catheter may be used immediately after placement without increasing the risk of infection. This was shown in a single center study in which 18 patients were started on in-center three times weekly peritoneal dialysis immediately after catheter placement [5]. Compared with 9 patients who waited two weeks prior to starting dialysis, urgent initiation was associated with no greater risk of peritonitis or exit site infection at three months.

To minimize the risk of fluid leak, it is preferable to wait at least 10 to 14 days after catheter insertion before beginning peritoneal dialysis. If PD is required less than 10 days following catheter placement, small volume exchanges (ie, less than 1500 mL) performed in the recumbent position only (eg, with a cycler or chronic ambulatory peritoneal dialysis with supine dwells only) can be performed with little risk of a significant leak.

Some may choose to "lock" the PD catheter during temporary cessation of PD in an attempt to avoid clotting of the PD catheter. Heparin can be used for this purpose in the same dosages used to lock hemodialysis catheters, as the heparin is not peritoneally absorbed. Others may elect not to lock the PD catheter as the risk of catheter occlusion during non-use is probably l .

The modified GRADE system defines both the strength of the recommendations of the guideline authors and the level of evidence upon which each of the recommendations is based. This grading system classifies expert recommendations as “strong” (Grade 1) or “weak” (Grade 2) based upon the balance between the benefits and risks, burden, and cost. The quality or level of evidence is designated as high (Grade A), moderate (Grade B), low (Grade C), or very low (Grade D) depending on factors such as study design, directness of evidence, and consistency of results. Grades of recommendation and quality of evidence may range from 1A to 2D. The GRADE system was developed by an international group of guideline developers and methodologists to maximize the usefulness of clinical practice guidelines in the management of typical patients (1–7). Most guideline organizations recognize the need for a standard grading scheme and the GRADE system has been adopted by many leading organizations, including NICE, SIGN, KDIGO, ERBP, and KDOQI, as well as UpToDate (8,9).

GUIDELINE (1) : THE ACCESS TEAM

We recommend that each center should have a dedicated team involved in the implantation and care of peritoneal catheters. Rationale: The access team should comprise nurses, nephrologists, and surgeons who have experience in peritoneal dialysis (PD). Each member of the team should understand the importance to the patient of successful access placement and the need for attention to detail in the reduction of complications

GUIDELINE (2) : TIMING AND COORDINATION OF REFERRAL AND SURGERY

2.1 Timing and Coordination of Referral and Surgery : We suggest that, whenever possible, catheter insertion should be performed at least 2 weeks before starting PD. Small dialysate volumes in the supine position can be used if dialysis is required earlier. Rationale: There are two main patient groups requiring PD access:

1. Patients with progressive renal failure predicted to need dialysis: For these patients, access should be Coordinated from the chronic kidney disease low clearance clinic. The objective is placement of access sufficiently early 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 vascular access for hemodialysis if there are problems with catheter function. It is not recommended that patients commencing PD have an arteriovenous fistula formed unless there is a plan to transfer to hemodialysis within a few months or some clinical doubt regarding the viability of PD in a given patient beyond a few months.
2. Patients with stage 5 chronic kidney disease presenting as uremic emergencies [late referrals] For these patients there should be a pathway that allows the choice ofPD as a modality. This requires adequate patient education to be available to permit choice. The advantage of placing PD access in patients who have not had the opportunity to be prepared for renal replacement therapy is that the requirement for prolonged use of central venous access can be reduced.This has to be balanced against the potential for complications associated with the early use of PDcatheters (12).

GUIDELINE (3) : IMPLANTATION PROTOCOL

Implantation Protocol : We recommend that renal units should have clear protocols for perioperative catheter care, including the use of antibiotic prophylaxis. Rationale: The following points should be included in the perioperative catheter care protocol:

- Preoperative: checking for hernias and screening for methicillin-resistant Staphylococcus aureus (MRSA) and nasal carriage of S. aureus; identifying a catheter of a suitable length; marking the exit site with the patient sitting or standing.
- Pre-implantation: preparing the bowel with laxatives; ensuring bladder emptying; administering prophylactic antibiotics; preparing surgical site according to NICE guidance (14).
- Post-procedure: flushing catheter and capping off using suitable dialysate; covering exit site with a suitable nonocclusive dressing and, if possible, not disturbing for 5 – 10 days; immobilizing the catheter;

discharging patient home with supply of aperients and advice on recognizing potential complications.

Once the catheter is placed and until healing is completed, the dressing changes should be done by a dialysis nurse using sterile technique. Administration of prophylactic antibiotics is recommended

to reduce the risk of catheter-site infection, peritonitis, and wound sepsis and there is randomizedcontrolled trial (RCT) evidence for the use of vancomycin (15). The Cochrane Collaboration found four trials of intravenous antibiotics and found the evidence to be strong in preventing catheter insertion-associated early peritonitis but not tunnel or exit-site infection (16). This evidence is also reviewed in the ISPD peritonitis guidelines (17). The choice of antibiotic should be **based upon local guidelines**, with consideration given to efficacy, risks of selection of resistant organisms, and development of Clostridium difficile colitis.

GUIDELINES (4) : THE IMPLANTATION TECHNIQUE

4.1 The Implantation Technique : We recommend that **local expertise** at individual centers should govern the choice of method of PD catheter insertion.

4.2 The Implantation Technique : We recommend that each PD unit should have the ability to manipulate or reimplant PD catheters when necessary.

4.3 The Implantation Technique : We recommend that urgent removal of PD catheters should be available where necessary. Rationale: Catheter removal is indicated either acutely

in the case of PD peritonitis or as a planned procedure, for example, following renal transplantation or switch to hemodialysis. For the planned procedure, catheter removal can be performed as a day case. Under certain circumstances, simultaneous removal and replacement has been described for certain indications, for example, localized exit-site infection or during remission following relapsing peritonitis (18). This should not be done for tunnel infection or active peritonitis.

4.4 We recommend that timely surgical support should be available for the review of PD patients. Rationale: There is no RCT evidence to support one method of insertion over another; however, the method needs be determined by patient characteristics. For more complicated patients, including those with previous significant abdominal surgery, a technique that involves direct vision is necessary, such as laparoscopic or open insertion (19).

Peritoneal access surgery is generally considered part of the overall requirement for dialysis access and should include facilities for both catheter insertion and catheter removal. Data from the UK Renal Registry indicate that the incident renal replacement population was 113 per million of the population in 2004, with 20% starting on PD (11). About two thirds of catheter insertions in the UK are performed using the open surgical technique and the majority of the others are done using the medical percutaneous technique

GUIDELINE (5) : FACILITIES FOR PD CATHETER INSERTION

5.1 Facilities for PD Catheter Insertion :We recommend that a dedicated area should be used for catheter insertion, with appropriate staffing, suction, oxygen, and patient monitoring facilities.

Rationale: The anesthetic requirement depends on the technique selected, which is influenced by the characteristics of the patient. Typically, for percutaneous or peritoneoscopic routes, sedation may be required (20). Conscious sedation needs to be managed according to local clinical governance procedures.

5.2 Facilities for PD Catheter Insertion

We suggest that no particular catheter type has been proven to be better than another Rationale: The Cochrane Review did not find any advantage for straight versus coiled catheters, single or

double cuff, median or lateral incision (21). However, a RCT reported improved primary catheter function (22) and improved PD technique survival for straight versus coiled catheters (23). A further RCT reported that coiled catheters might have higher migration rates than straight catheters (24). These data relate to relatively small studies and we would not advocate at this stage that centers with good outcomes change their choice of catheter type until more information is available. Although

subcutaneous burying of the catheter until use (Moncrief method) was not associated with a reduction

in infectious complications (25), its use may have advantages for the relationship between the timing of catheter insertion and the start of training.

5.3 Facilities for PD Catheter Insertion :

We suggest that a catheter of a suitable length should be used.

Rationale: It is good practice to make an assessment of the required length of the peritoneal catheter since a catheter of inappropriate length can lead to pain or impaired function (26,27). We draw attention to the publications by John Crabtree describing a method to determine the appropriate length for the PD catheter (27).

5.4 Facilities for PD Catheter Insertion :

We suggest that PD catheters should be inserted as day case procedures in selected cases as long as this does not compromise the quality of care. Rationale: The use of day care facilities has considerable advantages for the patient and resource utilization (28). However, local practices vary with respect to patient preparation and post-insertion care, and these should take priority over the length of in-patient stay (29).

GUIDELINE (6) : TRAINING FOR PD CATHETER INSERTION

6.1 Training for PD Catheter Insertion :

We recommend that PD catheter insertion training should be available to all trainees with an interest.

Rationale: Renal Association training committees should advise the inclusion of PD catheter insertion as

an optional component of the curriculum for trainees, although this will not be taken up by all trainees . A procedure-based competency for PD catheter insertion should be included in renal medicine specialty training curricula.

6.2 Training for PD Catheter Insertion :
We recommend that PD catheter insertion should not be delegated to inexperienced unsupervised operators.Rationale: Successful peritoneal access is crucial and should be performed by an operator (surgeon, special-ist nurse, or physician) with training and expertise in creating peritoneal access (10).

GUIDELINE (7) : AUDIT OF PD CATHETER INSERTION

7.1 Audit of PD Catheter Insertion : We recommend that there should be regular audit at not less than 12-month intervals of the outcome of catheter insertion as part of multidisciplinary meetings of the PD team and the access operators.
Rationale: There is RCT evidence to demonstrate that audit can improve practice . The primary marker of successful outcome is primary catheter patency. Although we do not have a specific audit standard in this area, it has been recommended that > 80% of catheters should be patent at 1 year (censoring for death and elective modality change) .The following are audit standards
for catheter-related complications:

- Bowel perforation: < 1%
- Significant hemorrhage: < 1%
- Exit-site infection within 2 weeks of catheter insertion:< 5%
- Peritonitis within 2 weeks of catheter insertion: < 5%
- Functional catheter problem requiring manipulation or replacement or leading to technique failure: < 20%

7.2 Data to be collected and used in the audit should include

- Perioperative complications, including bowel perforation and/or significant hemorrhage (requiringtransfusion or surgical intervention)
- Early infections: peritonitis and exit-site infections within 2 weeks of catheter insertion
- Dialysate fluid leak
- Catheter dysfunction at the time of first use that requires catheter manipulation or replacement or results in technique failure

SUGGESTED READINGS AND REFERENCES

1. Atkins D, Best D, Briss PA, Eccles M, Falck-Ytter Y, FlottorpS, et al.; GRADE Working Group. Grading quality of evidence and strength of recommendations. BMJ 2004; 328:1490.
2. Guyatt G, Gutterman D, Baumann MH, Addrizzo-Harris D, Hylek EM, Phillips B, et al. Grading strength of recommendations and quality of evidence in clinical guidelines: report from an American College of Chest Physicians task force. Chest 2006; 129:174–81.
3. Guyatt GH, Vist GE, Falck-Ytter Y, Kunz R, Magrini NSchünemann H. An emerging consensus on grading recommendations? ACP J Club 2006; 144:A8–9.
4. Guyatt GH, Oxman AD, Vist GE, Kunz R, Falck-Ytter Y, Alonso-Coello P, et al. GRADE: An emerging consensus on rating quality of evidence and strength of recommendations.BMJ 2008; 336:924–6.
5 Guyatt GH, Oxman AD, Kunz R, Jaeschke R, Helfond M, Liberati A, et al. GRADE: Incorporating considerations of mresources use into grading recommendations. BMJ 2008; 336:1170–3.
6 Guyatt GH, Oxman AD, Kunz R, Falck-Ytter Y, Vist GE, Liberati A, et al. GRADE: Going from evidence to recommendations. BMJ 2008; 336:1049–51.
7. Jaeschke R, Guyatt GH, Dellinger P, Schünemann H, Levy MM, Kunz R, et al. Use of GRADE grid to reach decisions on clinical practice guidelines when consensus is elusive. BMJ 2008; 337:327–30.
8. Uhlig K, MacLeod A, Craig J, Lau J, Levey AS, Levin A, et al. Grading evidence and recommendations for clinical practiceguidelines in nephrology. A position statement from Kidney Disease: Improving Global Outcomes (KDIGO). Kidney Int 2006; 70:2058–65.
9. Kidney Disease: Improving Global Outcomes. KDIGO clinical practice guidelines for the prevention, diagnosis, evaluation and treatment of hepatitis C in chronic kidney disease. Kidney Int Suppl 2008; (109):S1–99. 10. Flanigan M, Gokal R. Peritoneal catheters and exit-site practices toward optimum peritoneal access: a review of current developments. Perit Dial Int 2005; 25:132–9.
11 The Renal Association. Chapter 13: New adult patients starting renal replacement therapy in the UK in 2004. In: UK Renal Registry. The Eighth Annual Report 2005. Bristol, UK: The Renal Association; 2005: 15–38.
12 . Povlsen JV, Ivarsen P. How to start the late referred ESRD patient urgently on chronic APD. NephrolDial Transplant 2006; 21(Suppl 2):ii56–9.
13. Dombros N, Dratwa M, Feriani M, Gokal R, Heimburger O, Krediet R, et al. European best practiceguidelines for peritoneal dialysis. 3 Peritoneal access. Nephrol Dial Transplant 2005; 20(Suppl 9):ix8–12.
14. Leaper D, Burman-Roy S, Palanca A, Cullen K, Worster D,Gautam-Aitken E, et al. Prevention and treatment of surgical site infection: summary of NICE guidance. BMJ 2008;337:a1924.
15. Gadallah MF, Ramdeen G, Mignone J, Patel D, Mitchell L,Tatro S. Role of preoperative antibiotic prophylaxis in preventing postoperative peritonitis in newly placed peritonealdialysis catheters. Am J Kidney Dis 2000; 36:1014–19.
16. Strippoli GF, Tong A, Johnson D, Schena FP, Craig JC. Antimicrobial agents to prevent peritonitis in peritoneal dialysis: a systematic review of randomized controlled trials. Am J Kidney Dis 2004; 44:591–603. 17. Piraino B, Bailie GR, Bernardini J, Boeschoten E, GuptaA, Holmes C, et al. Peritoneal dialysis-related infections recommendations: 2005 update. Perit Dial Int 2005; 25:18. Mitra A, Teitelbaum I. Is it safe to simultaneously remove and replace peritoneal dialysis catheters? Review of the literature and suggested guidelines. Adv Perit Dial 2003;19:255–9.
19. Crabtree JH. Fluoroscopic placement of peritoneal dialysis catheters: a harvest of the low hanging fruits. PeritDial Int 2008; 28:134–7.
20. Zappacosta AR, Perras ST, Closkey GM. Seldinger technique for Tenckhoff catheter placement. ASAIO Trans 1991; 37:13–15.
21. Strippoli GF, Tong A, Johnson D, Schena FP, Craig JC. Catheter type, placement and insertion techniques for preventing peritonitis in peritoneal dialysis patients. Cochrane Database Syst Rev 2004; 4:CD004680.

22. Stegmayr BG, Wikdahl AM, Bergstrom M, Nilsson C, Engman U, Arnerlov C, et al. A randomized clinical trial comparing the function of straight and coiled Tenckhoff catheters for peritoneal dialysis. Perit Dial Int 2005; 25: 85–8.
23. Johnson DW, Wong J, Wiggins KJ, Kirwan R, Griffin A, Preston J, et al. A randomized controlled trial of coiled versus straight swan-neck Tenckhoff catheters in peritoneal dialysis patients. Am J Kidney Dis 2006; 48:812–21.
24. Lo WK, Lui SL, Li FK, Choy BY, Lam MF, Tse KC, et al. A prospective randomized study on three different peritoneal dialysis catheters. Perit Dial Int 2003;25. Danielsson A, Blohme L, Tranaeus A, Hylander B. A prospective randomized study of the effect of a subcutaneously "buried" peritoneal dialysis catheter techniqueversus standard technique on the incidence of peritonitisand exit-site infection. Perit Dial Int 2002; 22:211–19.
26. Crabtree JH, Burchette RJ, Siddiqi NA. Optimal peritonealdialysis catheter type and exit site location: an anthropometric analysis. ASAIO J 2005; 51:743–7.
27. Crabtree JH. Selected best demonstrated practices in peritoneal dialysis access. Kidney Int Suppl 2006; (103):S27–37.
28. Kelly J, McNamara K, May S. Peritoneoscopic peritoneal dialysis catheter insertion. Nephrology (Carlton) 2003; 8:315–17.
29. Henderson S, Brown E, Levy J. Safety and efficacy of percutaneous insertion of peritoneal dialysis catheters under sedation and local anaesthetic. Nephrol Dial Transplant 2009; 24:3499–504. Epub ahead of print 25 Jun 2009: doi:10.1093/ndt/gfp312.
30. Berns JS, O'Neill WC. Performance of procedures by nephrologists and nephrology fellows at U.S. nephrology training programs. Clin J Am Soc Nephrol 2008; 3:941–7.
31. Jamtvedt G, Young JM, Kristoffersen DT, O'Brien MA, Oxman AD. Audit and feedback: effects on professional practice and health care outcomes. Cochrane Database Syst Rev 2006; 2:CD000259.
32. Al-Hwiesh, et al. Peritoneal Dialysis International. InPress. doi: 10.3747/pdi.2012.00160

CHAPTER 4 NUTRITION IN ADULT PATIENTS ON PERITONEAL DIALYSIS

GUIDELINE (1) EVALUATIONS OF PROTEIN-ENERGY NUTRITIONAL STATUS
GUIDELINE (2) PREVENTION AND TREATMENT OF PROTEIN ENERGY WAISTING

The prevalence of protein energy wasting (PEW) in Peritoneal Dialysis Patients remain high. PEW is an important predictor of morbidity and mortality. Loss of appetite, inadequate protein and calorie intake, inflammation, loss of protein during dialysis, psychological factors and comorbid conditions are among the most common contributing factors.

GUIDELINE (1) : EVALUATIONS OF PROTEIN-ENERGY NUTRITIONAL STATUS

For maintenance dialysis patient's nutritional status should be routinely assessed every 3-6 months with combinations of complimentary measures:

Table 1. ISRNIM criteria for diagnosis of PEW in patients with ESRD

A diagnosis of PEW requires that at least three out of the four listed categories should be met and at least one test in each of the selected category should be included.

Serum Chemistry

- Serum albumin level (measured using the bromocresol green method) <38 g/l
- Serum prealbumin level (transthyretin) <30 mg/dl
- Serum cholesterol level <2.59 mmol/l (not valid if low concentrations are caused by abnormally high urinary of gastrointestinal protein losses, liver disease or cholesterol-lowering medicines)

Body mass

- BMI < 22 kg/m^2≤ 65 years, < 23 kg/m^2> 65 years (a lower BMI might be desirable for certain Asian populations; weight must be edema-free mass)
- Unintentional weight loss over time: ≥5% over 3 months or ≥ 10% over 6 months
- Total body fat percentage <10%

Muscle mass

- Muscle wasting: reduced muscle mass ≥ 5% over 3 months of ≥ 10% over 6 months
- Reduced MAMC area as measured by a trained anthropometrist (reduction > 10% in relation to the 50th percentile of the reference population)
- Creatinine appearance (of note, appearance is influenced by muscle mass and meat intake)

Diet intake

- Unintentionally low DPI < 0.80 g/kg per day for at least 2 months (which can be assessed by dietary diaries and interviews, or for protein intake by calculation of the normalized protein equivalent of total nitrogen appearance [normalized protein nitrogen appearance or normalized protein catabolic rate] as determined by urea kinetic measurements.
- Unintentional low DEI<25 kcal/kg per day for at least 2 months

Abbreviations: DEI dietary energy intake; DPI, dietary protein intake; ESRD, end-stage renal disease, ISRNM, International Society of Renal Nutrition and Metabolism; MAMC, mid-arm muscle circumference; PEW, protein-energy wasting.

1.1 Subjective Global Assessment (SGA).
1.2 Anthropometric measurements such as body weight, body mass index (BMI), skin fold thickness and mid arm muscle circumference.
1.3 Dietary assessment
1.4 Serum albumin and pre-albumin
1.5 Serum cholesterol
1.6 Body mass index (BMI)

1.7 Protein equivalent of total nitrogen appearance (PNA) or Protein catabolic rate (PCR)

Table2. Malnutrition score adapted from the SGA. Five scale parameters are employed and the values are summed. Maximum Duration of Haemodialysis = MDH. A value of 7 is normal, while 35 is severest malnutrition.

(A) **Patients related medical history**:					
1. Weight change (overall change in past 6 months)					
1 no weight change or gain	2 minor Wt loss (<5%)	3 wt loss 5 to 10%	4 wt loss 10 to 15%	5 wt loss > 15% in	☐
2. Dietary Intake					
1 no change	2 sub-optimal solid diet	3 Full liquid or moderate overall decrease	4 hypo-caloric liquid	5 starvation	☐
3. Gastrointestinal symptoms					
1 No symptoms	2 nurses	3 Vomiting or moderate GI symptoms	4 diarrhea	5 Severe anorexia	☐
4. Functional capacity (nutritionally related functional impairment)					
1 None (improved)	2 Difficulty with ambulation	3 Difficulty with normal activity	4 Light activity	5 Bed/chair ridden with no or little activity	☐
5. Co-morbidity					
1 MDH<12 months and healthy otherwise	2 MD 1-2 yrs or mid comorbidity	3 MDH 2-4 yrs or age>75 moderate co-morbidity	4 MDH>4 yrs or server co-morbidity	5 very severe multiple comorbidity	☐
(A) Physical Exam					
1. Decreased fat stores or loss of subcutaneous fat (below eyes, triceps, biceps, chest)					
1 None (no change)	2	3 moderate	4	5 severe	☐
2. Signs of muscle wasting (temple, clavicle, scapula, ribs, quadriceps, knee, interosseous					
1 None (no change)	2	3 moderate	4	5 severe	☐
Malnutrition Score: (sum of all)					☐

*Calculation of PNA in Peritoneal Dialysis Patients

PNA (PCR) = 15.1 + 0.195 urea appearance (mmol/24 h) + protein loss (g/24 h)

The 24 hours urea excretion by Peritoneal Dialysis and residual renal urea excretions is measured from a 24 hours collection of dialysate and urine. Preferably protein loss is also measured of protein losses are not assessed, a simplified equation can be used.
PNA (PCR) = 20.1 + 0.209 urea appearance (mmol/24 h)
The PNA should be normalized to body weight
n PNA = PNA/wt

GUIDELINE (2) : PREVENTION AND TREATMENT OF PROTEIN ENERGY WAISTING

Table 3. Management of PEW in Peritoneal Dialysis

General Management
- Maintain adequate dialysis dose
- Correct acidosis
- Manage comorbid or catabolic conditions
- Dietary counselling
- Encourage adequate food intake:

Daily energy intake 35kcal/kg of body weight for patients <60 years and 30-35 kcal/kg body weight for patients >60 years
Protein intake 1.2-1.3g/kg body weight per day*
- Oral nutritional supplements

Peritoneal dialysis-related therapies
- Preserve residual renal function
- Prevent and treat peritonitis
- Maintain optimal fluid balance
- Utilize amino acid-based solutions
- Use biocompatible solutions

Potential therapies
- Appetite stimulants
- Hormonal treatments (growth hormone; insulin-like growth factor I; anabolic steroids; ghrelin)
- Anti-inflammatory treatment

*1.0g/kg body weight per day can be acceptable unless there is evidence of declining nutritional status,
Abbreviation: PEW, protein-energy wasting.

2.1 All patients should receive nutritional counselling
2.2 Dietary protein intake (DPI)
2.2.1 The recommended DPI is 1.2-1.3 g/kg/d at least 50% of the dietary protein should be of high biological value
2.3 The recommended daily energy intake is 35 kcal/kg/d for those less than 60 years and 30-35 kcal/kg/d for 60 years or older.
2.4 The dialysis adequacy should be assessed and under dialysis should be excluded
2.5 Any potential treatable condition or medications that might interfere with appetite should be eliminated or treated
2.6 Preservations of residual renal function
2.7 Evaluate for the presence of inflammation
2.8 Investigate for taste abnormalities gastrointestinal problem, emotional and psychological disorders social constraints (poverty), glucose absorption from the PD solutions, abdominal fullness induced by dialysate and loss of nutrients into the dialysate

2.9 Oral supplement with protein
2.10 Once daily intraperitoneal amino acid (1.1%) solution should be considered.
2.11 Correction of acidosis
2.12 Appetite stimulants such as megestrol acetate may be considered for some patients
2.13 For severe PEW that did not respond to the above measure tube feeding should be considered.
2.14 Common sources of protein, sodium, phosphorous and potassium.
2.14.1 Protein Rich Food include

- Fresh meats
- Chicken and Turkey
- Fish and other seafood
- Eggs or egg white

2.14.2 Sodium and Fluids.

- Table salt
- Food that have added table salt such as:
- Garlic or onion salt
- Soy sauce
- Teriyaki sauce
- Must canned foods
- Salted snack foods like chips and crackers
- Most restaurant and take out foods

2.14.3 Phosphorous Rich Food.

- Dairy product such as milk, cheese, yogurt, ice cream and pudding
- Nuts and peanut butter
- Dried beans and peas
- Beverages such as a cola drinks
- Phosphate additives
- Chicken nuggets and hotdogs

2.14.4 High Potassium Food

- Certain fruits and vegetables
- Bananas, melons, oranges, potatoes and tomatoes
- Milk and yogurt
- Dried beans and peas
- Most salt substitutes
- Protein rich foods such as meats and fish
- Dates

SUGGESTED READING:

1. Han, S.-H & Han, D.-S. *Nat. Rev. Nephrol*. 8, 163-175 (2012); published online 7 February 2012; doi:10.1038/nrneph.2012.12
2. Nephrol Dial Transplant (2005) 20 [Suppl 9]: ix28-ix33 doi:210.1093/ndt/gfil122
3. Nephrol Dial Transplant (2007) 22 [Suppl 2]: ii45-ii87 doi:10.1093/ndt/gfm020

CHAPTER 5 PERITONEAL DIALYSIS RELATED INFECTIONS IN ADULT

Peritoneal Dialysis (PD) related infectious defined as exit site infection (ESI), tunnel infection (TI) and Peritonitis. It is the leading complication of PD. Peritonitis is the most common cause of technique failure.

GUIDELINE (1) : MONITORING OF PD RELATED INFECTIONS

Every program should monitor infection rates at least quarterly.

1.1 A team approach for continuous quality improvement (CQI) generally includes nephrologists, nurses, social workers and dietitians is the key to a successful PD program.

1.2 Causatine organisms, their antibiotic sensitivity and presumed etiology must be reviewed in regular fusion.

1.3 The center's peritonitis rate should be no more than one (1) episode every twenty four (24) months (0.5/year at risk).

1.4 Method for reporting PD related infections as rates: Months of PD at risk divided by number of episodes and expressed as interval in months between episodes.

1.5 Infection rates for individual organisms should also be calculated.

GUIDELINE (2) : EXIT SITE INFECTION (ESI)

2.1 ESI is defined by the presence of purulent drainage with or without pericatheter erythema.

2.2 Pericatheter erythema without purulent drainage can be a simple skin reaction and needs to be followed carefully.

2.3 Positive culture in the absence of an abnormal appearance is indicate of colonization rather than infection, so intensification of exit site (ES) cleaning with antiseptic is advised.

2.4 Do gram stain and culture from purulent drainage.

GUIDELINE (3) : TUNNEL INFECTION (TI)

3.1 TI may present as erythema, edema or tenderness over the subcutaneous pathway but is often clinically occult.

3.2 TI usually occurs in the presence of ESI but rarely occurs alone.

3.3 Ultrasonographic study is needed to support the diagnosis.

GUIDELINE (4) : THERAPY FOR ESI AND TI

4.1 ESI and TI caused by staphylococcus aureus and Psendomonas aeruginosa for the majority of infection.

4.2 Oral antibiotic therapy has been shown to be as effective as intra -peritoneal (IP) antibiotic therapy with the exception of Methicillin Resistant S. Aureus (MRSA).

4.3 Intensify ES cleaning with antiseptics and recheck the technique.

4.4 Culture with sensitivity testing is important in determining antibiotic therapy.

4.5 Check exit site and tunnel one week after starting and one to two weeks after the discontinuation of antimicrobial treatment and repeat gram stain and culture in case the presence of purulent drainage.

4.6 Catheter replacement as single procedure under antibiotic coverage should be done if therapy more than three weeks with appropriate antibiotics fails to resolve the infection.

4.7 Catheter replacement as single procedure should be considered earlier with a new exit site and tunnel in case of tunnel infection (TI).

4.8 Patient with ESI that progresses to peritonitis or who presents with ESI in conjunction with peritonitis with same organism will usually require catheter removal.

4.9 Empiric antibiotic therapy for ESI/TI:

4.9.1 Amoxicillin 250-500mg orally twice daily or

4.9.2 Cephalexin 500mg orally b.i.d. to t.i.d. or

4.9.3 Ciprofloxacin 250mg orally b.i.d. if the patient has history of Pseudomonas Aeruginosa ESI.

4.10 Gram positive organisms ESI/TI theraphy:

4.10.1 Amoxicillin 250 – 500mg orally b.i.d. or

4.10.2 Cephalexin 500mg orally b.i.d. to t.i.d.

4.10.3 Two (2) weeks is the minimum duration therapy, antibiotic therapy must be continued until ES appears entirely normal.

4.11 Gram negative organisms other than Pseudomonas aeroginosa ESI/TI therapy:

4.11.1 Ciprofloxacin 250mg orally b.i.d.

4.11.2 Two (2) weeks is the minimum duration therapy, antibiotic therapy must be continued until ES appears entirely normal.

4.12 PseudemonasAeruginosa ESI/TI therapy:

4.12.1 Ciprofloxacin 250mg orally b.i.d.

4.12.2 Add Ceftazidime or Aminoglycoside IP if resolution of the infection is slow or if there is recurrent Pseudomonas ESI.

4.12.3 Three (3) weeks is the minimum duration therapy, antibiotic therapy must be continued until ES appears entirely normal.

4.12.4 Catheter replacement as single procedure should be considered earlier with a new exit site and tunnel.

4.13 MRSA ESI/TI therapy:

4.13.1 Vancomycin:

- Loading dose 30mg/kg (maximum 2g per dose) IP with dwell of at least 6 hours.
- Repeat dosing 15mg/kg (maximum 2g per dose) IP with dwell of at least 6 hours every 3 – 5 days aim to keep serum through levels above 15mg/l (µg/ml)

4.13.2 Three (3) weeks is the minimum duration therapy, antibiotic therapy must be continued until ES appears entirely normal.

GUIDELINE (5) : PERITONITIS

5.1.1 Patient with peritonitis usually present with cloudy fluid and abdominal pain and confirmed by effluent cell count with white blood cells (WBC) more than 100/µLwith at least 50% polymorphnuclearneutrophilic cells after a dwell time at least 2 hours and positive effluent culture.

5.1.2 The abdomen should be drained and the effluent carefully inspected and sent for cell count with differential, gram stain and culture.

5.1.3 Peripheral blood cultures should be obtained if the patient appears septic.

5.1.4 Do one or two rapid exchanges to relieve pain.

5.1.5 Patient with minimal pain can often be treated on outpatient basis with IP therapy.

5.1.6 Initiate empiric antibiotic therapy as soon as possible.

5.1.7 Heparin 500 units/L should be added to dialysate for patient with cloudy effluent.

5.1.8 Ensure clearfollow up arrangement or patient should be admitted.

5.1.9 Assess clinical improvement and repeat dialysis effluent cell count with differential and culture at days 3 to 5.

5.1.10 Differential diagnosis of cloudy effluent: infectious peritonitis, chemical peritonitis, eosinophilia of the effluent, hemoperitoneum, malignancy, chylous effluent and specimen taken from dry abdomen.

5.1.11 Differential diagnosis of abdominal pain and clear effluent: infectious peritonitis, constipation, renal or biliary colic, peptic ulcer disease, pancreatitis, and acute intestinal perforation.

5.2 APD patient who present during their night time treatment, polymorphonuclear cells above 50% is strong evidence of peritonitis even if WBC less than 100/µL.

5.3 APD patient without daytime exchange who present in daytime with abdominal pain, 1L at dialysate should be infused and dwell for 2 hours, then drained and examined for turbidity and sent for cell count with differential, gram stain and culture.

5.4 The patient's technique should be reviewed and if necessary, retraining should be performed by experienced PD nurse to prevent recurrence.

GUIDELINE (6) : SPECIMEN PROCESSING

6.1 Culture negative peritonitis should not be greater than 20% of episodes.

6.2 Optimal culture technique is the combination:

6.2.1 Bedside inoculation of 10ml effluent in two blood culture bottles.

6.2.2 Centrifugation of 50ml effluent at 3000g for 15 minutes followed by resuspension of the sediment in 3 – 5 ml of sterile saline and inoculation of this material both in solid culture media and into standard blood culture medium.

GUIDELINE (7) : EMPIRIC ANTIBIOTICS THERAPY FOR PERITONITIS

7.1 IP administration is superior to IV.

7.2 Intermittent and continuous dosing of antibiotics areequally efficacious.

7.3 Empiric antibiotics must cover both gram positive and gram negative organisms.

7.4 Gram positive organism empiric antibiotics coverage:

7.4.1 Cefazoline 20mg/kg (maximum 2g per dose) IP daily with dwell of at least 6 hours

or

7.4.2 Vancomycin if patient has history of MRSA, seriously unwell or has history of severe allergy to penicillins and cephalasporins or the center has an increased rate of MRSA:

7.4.2.1 Loading dose 30mg/kg (maximum 2g per dose) IP with dwell of at least 6 hours.

7.4.2.2 Repeat dosing 15mg/kg (maximum 2g per dose) IP with dwell of at least 6 hours every 3 – 5 days, aim to keep serum through levels above 15mg/L (µg/ml).

7.5 Gram negative organism empiric antibiotics coverage:

7.5.1 Ceftazidime 1500mg IP daily with dwell of at least 6 hours or

7.5.2 Gentamicin 0.6mg/kg (maximum 60mg per dose) IP daily with dwell of at least 6 hours.

GUIDELINE (8) : DRUG DELIVERY AND STABILITY

8.1 Vancomycin, aminoglycosides and cephalosporins can be mixed in the same dialysis solution bag.

8.2 Aminoglycosides and penicillins cannot be mixed in the same dialysis solution bag.

8.3 Separate syringes must be used for adding the antibiotics.

8.4 Use sterile technique by placing povidone iodine, rubbing with alcohol 70% stripe or chlorhexidine on medication port for 5 minutes prior to insertion of the needle through the port.

8.5 Icodextrin solutions are compatible with vancomycin, cefazolin, ceftazidime, gentamicin, ampicillin, cloxacillin and amphotericin.

GUIDELINE (9) : ADJUNCTIVE TREATMENT DURING ANTIBIOTIC THERAPY FOR PERITONITIS

9.1 Use oral nystatin500,000 units orally tidor fluconazole 200 mg orally daily during antibiotic therapy to prevent fungal peritonitis in program with high rates of fungal peritonitis.

GUIDELINE (10) : TERMINOLOGY FOR PERITONITIS

10.1 Recurrent: An episode that occurs within 4 weeks at completion of therapy of a prior episode but with different organism.

10.2 Relapsing: An episode that occurs within 4 weeks of completion of therapy of a prior episode with the same organism or 1 sterile episode.

10.3 Repeat: An episode that occurs more than 4 weeks after completion of therapy of a prior episode with the same organism.

10.4 Refractory: Failure of the effluent to clear after 5 days of appropriate antibiotics.

10.5 Catheter-related peritonitis: Peritonitis in conjunctions with an ESI or TI with the same organism or 1 site sterile.

10.6 Relapsing episode should not be counted as another peritonitis when calculating peritonitis rate.

GUIDELINE (11) : INDICATIONS FOR CATHETER REMOVAL FOR PERITONEAL DIALYSIS RELATED INFECTIONS

11.1 Refractory Peritonitis

11.2 Relapsing Peritonitis

11.3 Refractory ESI and TI

11.4 Fungal peritonitis

11.5 Catheter removal may also be considered for:

11.5.1 Repeat peritonitis

11.5.2 Mycobacterial peritonitis

11.5.3 Multiple enteric organisms

GUIDELINE (12) : COAGULASES NEGATIVE STAPHYLOCOCCUS PERITONITIS THERAPY

12.1 As 7.4

12.2 Duration of Therapy: minimum 14 days and at least 7 days after the effluent clears

12.3 Stop Gram Negative organism empiric antibiotics coverage (7.5)

12.4 Peritonitis with ESI or TI considers catheter removal and continue antibiotics therapy for 14-21 days.

GUIDELINE (13) : STAPHYLOCOCCUS AUREUS PERITONITIS THERAPY

13.1 As 7.4

13.2 Duration of therapy: 21 days

13.3 Step Gram Negative organism empiric antibiotics coverage (7.5)

13.4 Peritonities with ESI or TI seriously considered catheter removal and continue antibiotics therapy for 21 days.

GUIDELINE (14) : STREPTOCOCCUS AND ENTEROCOCCUS PERITONITIS THERAPY

14.1 Continue or start vancomycin as 7.4.2

14.2 Duration of therapy for streptococcus: 14 days

14.3 Duration of therapy for Enterococcus: 21 days

14.4 Stop empiric antibiotics coverage.

14.5 Peritonitis with ESI or TI consider catheter removal and continue antibiotics therapy for 21 days.

GUIDELINE (15) : CORYNEBACTERIUM PERITONITIS THERAPY

15.1 Continue or start vancomycin as 7.4.2

15.2 Duration of therapy: 21 days

15.3 Stop empiric antibiotics coverage.

15.4 Peritonitis with ESI or TI considers catheter removal and continues antibiotics therapy for 21 days.

GUIDELINE (16) : CULTURE NEGATIVE PERITONITIS THERAPY

16.1 Continue empiric antibiotics therapy as 7.4 and 7.5

16.2 Duration of therapy: minimum 14 daysand at least 7 days after the effluent clears

GUIDELINE (17) : GRAM NEGATIVE ORGANISMS OTHER THAN PSEUDOMONUSAERUGINOSA AND STENOTROPHOMONUS PERITONITIS THERAPY

17.1 As 7.5

17.2 Duration of therapy: 21 days

17.3 Stop gram positive organism empiric antibiotics coverage (7.4)

17.4 Peritonitis with ESI or TI considers catheter removal and continues antibiotics therapy for 21 days.

GUIDELINE (18) : PSEUDOMONAS AERUGINOSA PERITONITIS THERAPY

18.1 As 7.5

18.2 Add Ciprofloxacin 250mg P.O. BID

18.3 Duration of therapy : 21 days

18.4 Stop gram positive organisms empiric antibiotics coverage (7.4)

18.5 Remove PD Catheter if catheter infection (ESI/TI) is present or has preceded peritonitis.

18.6 Continue antibiotics after catheter removal via IV and oral routes for minimum of 2 weeks while the patient is on hemodialysis for total of 21 days.

GUIDELINE (19) : STENOTROPHOMONUS PERITONITIS THERAPY

19.1 As 7.5

19.2 Add Trimethoprim/sulfamethoxazole 960mg orally BID

19.3 Duration of therapy: 21 days

19.4 Stop gram positive organism empiric antibiotics coverage (7.4).

19.5 Peritonitis with ESI or TI consider catheter removal and continue antibiotics therapy for 21 days.

GUIDELINE (20) : MULTIPLE GRAM POSITIVE ORGANISMS PERITONITIS THERAPY

20.1 As 7.4

20.2 Duration of therapy: 21 days

20.3 Stop Gram Negative Organism empiric antibiotics coverage (7.5).

20.4 Remove PD catheter if catheter infection (ESI/TI) is present

20.5 Continue antibiotics after catheter removal via IV route for minimum of 2 weeks while the patient is on hemodialysis for total of 21 days.

GUIDELINE (21) : MULTIPLE GRAM NEGATIVE OR MIXED GRAM NEGATIVE AND GRAM POSITIVE ORGANISMS PERITONITIS THERAPY

21.1 As 7.5

21.2 Add Metronidazole 500 mg orally/IV Q8 hours.

21.3 Add Ampicillin 250mg orally/IV Q12 hours.

21.4 PD Catheter may need to be removed particularly if laparotomy indicates intra-abdominal pathology.

21.5 Continue antibiotics after catheter removal via IV route for minimum of 2 weeks while the patient is on hemodialysis for total of 21 days.

21.6 Obtain urgent surgical assessment.

21.7 Does computed tomography (CT) scan looking for intra-abdominal pathology such as diverticulitis, cholecystitis, ischemic bowel, appendicitis, abscess, etc.

GUIDELINE (22) : FUNGAL PERITONITIS THERAPY

22.1 Do multiple rapid exchange until the fluid is clear.

22.2 Remove PD Catheter as soon as possible.

22.3 Stop empiric antibiotics coverage.

22.4 Empiric coverage:

22.4.1 Fluconazole 200mg orally daily or

22.4.2 For patient who have had significant prior exposure to azole antifungals:

22.4.2.1 Amphotericin B 0.6mg/kg/day IV or

22.4.2.2 Cospofungin70mg IV on day 1 with subsequent dosing 50mg IV daily.

22.5 Therapy can be tailored to the specific organism that has been isolated.

22.6 Duration of therapy: 4 weeks and until all symptoms and sign have resolved after catheter removal while the patient is on hemodialysis.

22.7 Reinsert new PD Catheter at least 4-6 weeks after catheter removal.

GUIDELINE (23) : MYCOBACTERIA PERITONITIS THERAPY

23.1 Investigate for pulmonary and extra pulmonary disease

23.2 Start therapy with four (4) drugs.

23.2.1 Rifampicin 10mg/kg/day (maximum 600mg/day) orally.

23.2.2 Isoniazid 5mg/kg/day (maximum 300mg/day) orally.

23.2.3 Pyrazinamide 25 – 35mg/kg/dose 3 times per week orally.

23.2.4 Ofloxacin 200mg orally daily.

23.3 Add pyridoxine 50 – 100mg orally daily to avoid isoniazid induced neurotoxicity

23.4 Duration of therapy:

23.4.1 Pyrazinamide and Ofloxacin for 3 months.

23.4.2 Rifampicin, Isoniazid and Pyridoxine for 12 – 18 months. Consider PD Catheter removal. Reinsert new PD Catheter after 6 weeks of anti-tuberculous treatment.

GUIDELINE (24) : CATHETER REINSERTION FOR PERITONEAL INFECTION

24.1 Catheter replacement as single procedure:

24.1.1 Refractory catheter infections (ESI/TI)

24.1.2 Relapsing peritonitis if the effluent is clear

24.2 Catheter reinsertion after a minimum period of 3-4 weeks from removal

24.2.1 Refractory peritonitis

24.2.2 Fungal peritonitis (may consider later reinsertion 4-6 weeks.

SUGGESTED READINGS:

1- Li PK , Szeto CC , Piraino B , et al : Peritoneal Dialysis-Related Infections Recommendations : 2010 Update . Perit Dial Int 2010 ; 30 : 393-423

2- Piraino B , Bernardini J , Brown E , et al : ISPD Position Statement on Reducing The Risks of Peritoneal Dialysis-Related Infections . Perit Dial Int 2011 ; 31 (6) : 614-630

3- Daugirdas JT , Blake PG , Ing TS : Handbook of Dialysis

4- www.uptodate.com :
Clinical Manifestations and Diagnosis of Peritonitis in Peritoneal Dialysis
Pathophysiology and Prevention of Peritonitis in Peritoneal Dialysis
Microbiology and Therapy of Peritonitis in Continuous Peritoneal Dialysis
Fungal Peritonitis in Continuous Peritoneal Dialysis.

CHAPTER 6 NON-INFECTIOUS COMPLICATIONS IN ADULT PERITONEAL DIALYSIS

GUIDELINE (1) : CATHETER MALFUNCTION

Defined as incomplete recovery of 50 % instilled dialysate volume.

1.1 Obstruction

1.1.1 PD catheters may exhibit obstruction during either the infusion or drain phases of an exchange.

1.1.2 Infusion Failure:

1.1.2.1 Usually reflect intraluminal obstruction by fibrin or clot.

1.1.2.2 Flushing the catheter with heparinized saline may be beneficial.

1.1.2.3 Thrombolytic therapy may be needed.

1.1.3 Draining Failure, this can be related to the following etiologies.

1.1.3.1 Distended loops of bowel due to constipation will often impair catheter outflow by occluding many of the holes on the distal end of the PD catheter.

1.1.3.1.1 Should be managed with appropriate laxative therapy to get 2-3 bowel movements/day.

1.1.3.2 Adhesions due to prior peritonitis or surgery may cause the catheter to be trapped in a loculated compartment.

1.1.3.2.1 Surgical lysis or catheter repositioning/replacement may be necessary.

1.1.3.3 Omental wrapping

1.1.3.4 Most commonly presents within the first few weeks of initiating PD and is generally painless.

1.1.3.4.1 Omentectomy is often necessary.

GUIDELINE (2) : MALPOSITION

2.1 Causes:

2.1.1 Inappropriate catheter placement at the time of insertion

2.1.2 More commonly due to migration of the catheter tip out of the pelvic gutter into the upper abdomen.

2.2 Clinical presentations:

2.2.1 Discomfort localized by the patient to the site of the catheter.

2.2.2 Poor catheter drainage

2.3 Management

2.3.1 Plain x ray of abdomen is needed to assess catheter position.

2.3.2 Catheter tips that have migrated to the left upper quadrant may spontaneously reposition themselves secondary to the actions of peristalsis favoring downward movement of the catheter on the left side.

2.3.3 Spontaneous repositioning of a catheter that has migrated into the right upper quadrant is very unlikely.

2.3.4 When catheter malfunction due to migration is present and spontaneous repositioning does not occur, mechanical intervention is necessary.

2.3.4.1 The catheter position may be corrected by intraluminal manipulation with a stiff guide wire, use of a Fogarty catheter, or surgery (often laparoscopic).

GUIDELINE (3) : SCLEROSING ENCAPSULATING PERITONITIS (SEP)

3.1 It is a rare but serious complication characterized by thick-walled membranous encasing and entrapping loops of bowel.

3.2 Clinical presentation:

3.2.1 Abdominal pain, nausea, emesis, bowel obstruction (either small or large)

3.2.2 Ultrafiltration failure with poor solute transport.

3.2.3 SEP may present years after discontinuation of PD, even after renal transplantation.

3.3 The mortality rate is greater than 50% despite medical and surgical treatment.

3.4 The diagnosis of EPS is generally made by CT scanning which demonstrates peritoneal calcification, bowel thickening, bowel tethering, and bowel dilatation.

3.5 The treatment of EPS often entails cessation of peritoneal dialysis with transfer to hemodialysis.

GUIDELINE (4) : ULTRAFILTRATION FAILURE (UFF)

4.1 A diagnosis of UFF is made when net UF < 400 ml with 4.25% glucose PDF dwelled for 4 hours, in the absence of catheter malfunction, fluid leaks or extensive intraperitoneal adhesions.

4.2 There are three types of UFF:

4.2.1 Type I membrane failure – associated with rapid solute transport

4.2.2 Type II membrane failure – associated with impaired solute transport

4.2.3 Type III membrane failure – associated with excessive lymphatic absorption.

4.3 Type I membrane failure

4.3.1 It is the most common cause of UFF.

4.3.2 It is characterized by increased transport of low molecular weight solutes and rapid glucose absorption with loss of the osmotic gradient is due to increased effective peritoneal surface area through vascular neoproliferation, increased vascular permeability and impaired aquaporin mediated water transport.

4.3.3 Type I UFF also occurs during peritonitis, however, its usually reversible.

4.3.4 Treatment

4.3.4.1 Shortening the dwell time of each exchange and if patient is on CAPD consider switching to APD.

4.3.4.2 Using more frequent hypertonic exchanges.

4.3.4.3 Use of icodextrin dialysate.

4.3.4.4 Use of diuretics in patients with residual renal function.

4.3.4.5 Consider temporary cessation of PD and resting the abdomen for 4-6 weeks.
4.3.4.6 Occasionally patients with ultrafiltration failure may require maintenance hemodialysis.
4.4 Type II Membrane Failure
4.4.1 Decreased solute and fluid removal with repeat PET.
4.4.2 Causes: Peritonitis, extensive adhesions resulting from previously severe peritonitis, or sclerosing encapsulated peritonitis (SEP).
4.4.3 Low ultrafiltration with absence of sodium sieving.
4.4.4 Use larger dwell volume as tolerated.
4.4.5 Use more frequent exchange and avoid dry periods.
4.5 Type III Membrane Failure
4.5.1 Increase in lymphatic absorption results in rapid loss of net UF
4.5.2 Diagnosis:
4.5.2.1 Low drain volume with no change in membrane type.
4.5.2.2 Diagnosis of exclusion as it is difficult to measure lymphatic reabsorption rate.
4.5.3 May need to switch to other modalities of renal replacement therapies.

GUIDELINE (5) : HEMOPERITONEUM

5.1 The overall incidence is 6 % and 60% in menstruating women.
5.2 Causes: Ovulation, retrograde menstruation, and endometriosis are common benign causes of hemoperitoneum among menstruating women. Other causes include catheter-related problems, such as lacerations or contusions; sclerosing peritonitis; or retroperitoneal pathology, such as cyst rupture or renal tumors.
5.3 The diagnosis is based on clinical assessment.
5.3.1 For the first occurrence of mild, self-limited bleeding in a non-menstruatingpatient, obtaining peritoneal fluid erythrocyte count, white blood cell count, amylase, culture, and peripheral white blood cell count is indicated.
5.3.2 Heavy or recurrent bleeding or bleeding that is associated with pain and fever requires urgent evaluation. Physical findings such as a rebound or guarding should be treated asa surgical emergency. A peritoneal fluid white blood cell count, differential, culture, and amylase should be obtained.
5.3.3 A dialysate spun hematocrit >2 percent suggests significant intraperitoneal pathology.
5.3.4 Surgical consultation should be obtained with consideration of early laparoscopy or laparotomy.
5.3.5 Imaging studies, such as an abdominal computed tomography (CT) scan, ultrasound, or magnetic resonance imaging (MRI), may be indicated. Angiography is a last resort that may be required for more definitive diagnosis.
5.4 Treatment:
5.4.1 Manage the underlying cause is essential.
5.4.2 Supportive measures is indicated for benign cause which include:
5.4.2.1 Instillation of heparin (500 units/L) in the dialysate to prevent clotting in the peritoneal catheter
5.4.2.2 Frequent exchanges till clear draining.
5.4.2.3 Use of room-temperature dialysis exchanges.
5.4.2.4 Oral contraceptives to prevent ovulation and control bleeding among menstruating women.
5.4.2.5 Stopping aspirin or other anticoagulants should be balanced against the therapeutic indications in the individual patient.

GUIDELINE (6) : HERNIAS

6.1 Relatively common complication occurring in 15% of all PD patients.

6.2 Hernias may be incisional (catheter site or other), ventral, umbilical, or inguinal.

6.3 Hernias often present with painless swelling at different sites, discomfort or disfigurement, and problems related to a complication from the hernia which include intestinal obstruction, incarceration, or strangulation and present with symptoms of peritonitis.

6.4 Diagnosis is usually based on clinical examination.

6.5 Prevention: Several measures can be taken to reduce the risk of hernia. These include:

6.5.1 Detection and repair of preexisting hernias before insertion of the catheter.

6.5.2 Detection and repair of a patent processus vaginalis by the surgeon during insertion of the peritoneal catheter.

6.5.3 Use of Paramedian catheter placement instead of midline.

6.5.4 Liberal use of agents in the early postoperative period to prevent constipation and coughing.

6.6 Treatment

6.6.1 Patients who develop a hernia after the initiation of PD should undergo elective repair.

6.6.2 Peritoneal dialysis may frequently be resumed within several days of the herniotomy, using low volume, supine, rapid cycling PD with gradual reinstitution of the former PD regimen in the subsequent two to four week period.

6.6.3 Provide HD backup if needed in patients with no residual renal function in whom small volume frequent exchanges are insufficient to control azotemia.

GUIDELINE (7) : DIALYSATE LEAKAGE

7.1 Clinical presentation

7.1.1 Dialysate may leak through congenital (e.g., patent processus vaginalis) or acquired (eg, pericatheter or prior incisional site) abdominal wall defects results in dissection of dialysate through soft tissue and fascial planes.

7.1.2 Genital (scrotal or labial) edema or generalized swelling of the abdominal wall and/or upper thigh, frequently with a peaud'orange appearance.

7.2 Diagnosis

7.2.1 Computed tomographic peritoneography are usually diagnostic. The latter may be performed without radiocontrast, as the presence of the dialysate itself may serve in this fashion and allow for definition of the defect.

7.3 Treatment

7.3.1 Dialysate leaks resolve after temporary cessation of PD or a switch to nocturnal intermittent PD in patient with pericatheter leak. Ensure that there is no exit site infection.

7.3.2 Surgical repair is nearly always necessary for patent process vaginalis.

GUIDELINE (8) : HYDROTHORAX

8.1 Clinical presentation

8.1.1 Hydrothorax is a rare complication (2%) of PD.
8.1.2 More common in female.
8.1.3 Commonly manifest within the first month of initiating PD; onset later than 1 year after the initiation of PD is uncommon.
8.1.4 Peritoneal dialysate transits the diaphragm through congenital diaphragmatic defects.
8.1.5 Nearly 90% of cases occur on the right side.
8.1.6 Patients present with progressive dyspnea and/or orthopnea.
8.2 Diagnosis
8.2.1 The pleural fluid is transudative and has a high glucose and lactate concentration.
8.2.2 The diagnosis is confirmed by demonstrating communication between the peritoneal and pleural spaces. This may be accomplished by injecting radiolabeled albumin or technetium sulfur colloid into the peritoneal cavity and imaging the chest after allowing the patient to ambulate for an hour.
8.3 Treatment
8.3.1 Patients may require thoracentesis for initial relief of symptoms.
8.3.2 PD should be temporarily discontinued or, at a minimum, changed to a modality associated with lower peak intraabdominal pressures, eg, lower volumes or nocturnal intermittent PD
8.3.3 Pleurodesis with talc, triamcinolone, autologous blood, tetracycline derivatives, fibrin glue may be attempted in case of recurrence. Use of video-assisted thoracoscopicpleurodesis is recommended.
8.3.4 Surgical repair via a limited thoracotomy is indicated if pleurodesis fails.
8.3.5 Alternatively, patients may elect to transfer to hemodialysis.

GUIDELINE (9) : PAIN

9.1 Patients performing PD may experience pain associated with either the inflow or drain phases of a PD exchange.
9.2 Pain on Inflow
9.2.1 Commonly due to “jet” effect of dialysate emerging from the distal end of the catheter at relatively high velocity, thereby irritating the adjacent tissues.
9.2.2 More frequent with straight catheters, relatively low dialysate pH and hypertonic solutions.
9.3 Treatment
9.3.1 Addition of lidocaine to solution bags prior to infusion.
9.3.2 Use of normal pH fluids or biocompatible solutions.
9.4 Pain on Outflow
9.4.1 Due to suction effect on intra-abdominal viscera.
9.4.2 Commonly localizes to the rectal or suprapubic areas.
9.4.3 Treatment
9.4.3.1 Usually resolve with time.
9.4.3.2 Pain may be lessened by incomplete drainage (eg, tidal dialysis).

9.4.4 Back Pain

9.4.4.1 It is due to either alterations in posture of lumbar spine induced by intraperitoneal fluid and/or due to the weight of the fluid itself on patients in CAPD.

9.4.4.2 Treatment with change to APD with no or minimal daytime dwell volumes.

Fibrin clot heparin (at a dose of 200 to 500 units per liter) is usually added when plugs or strands of fibrin are visible in the drained fluid, tPA (8 mgs in 10 ml of sterile water injected into the catheter and allowed to dwell for 1 hour). The effectiveness of this procedure varied between individuals and with the size and viscosity of the clot. If successful, lysis was followed by the instillation of heparin in the dialysate for several exchanges.

GUIDELINE (10) : AUDIT MEASURES FOR PERITONEAL DIALYSIS ON INFECTIOUS COMPLICATIONS

10.1 Audit Measure 1: Catheter complications and their resolution

10.2 Audit Measure 2: Frequency of solute clearance (residual and peritoneal) estimation

10.3 Audit Measure 3: Cumulative frequency curves for the total solute clearance

10.4 Audit Measure 4: Frequency of measurement of membrane function, residual urine and peritoneal ultrafiltration volume

10.5 Audit Measure 5: Identify patients with fluid reabsorption in long dwell

10.6 Audit Measure 6: Number of patients regularly requiring hypertonic (3.86% glucose) exchanges to maintain fluid balance.

10.7 Audit Measure 7: Identify patients with a total fluid removal <750 ml per day.

SUGGESTED READING:

1. International Society of Peritoneal Dialysis Guidelines. http://www.ispd.org/lang-en/treatmentguidelines/guidelines
2. Handbook of Peritoneal Dialysis by Steven Guest MD. Publisher: Create Space Independent Publishing Platform; 1 edition (February 4, 2011). ISBN-13: 978-1449906139.
3. Comprehensive Clinical Nephrology: Expert Consult. Publisher: Mosby; 4 edition (November 22, 2010). ISBN-13: 978-0323058766.
4. Brenner and Rector's The Kidney: Expert Consult. Publisher: Saunders; 9 edition (December 1, 2011). ISBN-13: 978-1416061939

PART 2
PEDIATRIC PERITONEAL DIALYSIS CLINICAL GUIDELINES

CHAPTER 7 PEDIATRIC PERITONEAL DIALYSIS PRESCRIPTION AND ADEQUACY

GUIDELINE (1) : INITIATION OF PERITONEAL DIALYSIS

1.1 Time to initiate dialysis**:**

1.1.1 Dialysis in children should be initiated when updated estimated Glomerular Filtration Rate (eGFR) less than 15 ml/min/1.73 m^2 and/or when there are symptoms and signs of uremia and/or growth failure .

1.1.1.1 Dialysis initiation will be individualized based on assessment of nutrition, growth and development .

1.2 Choice of dialysis:
Peritoneal dialysis (PD) should be the mode of dialysis of choice in all infants and children unless contraindications exist such as omphalocele, gastroschisis, diaphragmatic hernia, obliterated peritoneal cavity and bladder exstrophy.

1.3 Preparation of the patient and family:

1.3.1 Once children reach a chronic kidney disease (CKD) stage 4 (eGFR < 30 mL/min/1.73 m^2), a thorough education about renal replacement therapy, including kidney transplantation, PD and Hemodialysis (HD) should be discussed with them and with their parents.

1.3.2 Counseling for families of infants with antenatally or postnatally diagnosed kidney disease should be done and the final decision to start or withhold dialysis should be based as well in associated co-morbidities and their impact on their future survival and prognosis.

GUIDELINE (2) : PERITONEAL DIALYSIS PRESCRIPTIONS

2.1 Fill volume prescriptions:

2.1.1 Fill volume based on body surface area (BSA) should be used in children.

2.1.2 Fill volume in children and infants should be individualized and adjusted based on nutritional needs and urine output as well as clinical control and biological adequacy parameters such as urea and creatinine levels.

2.2 Optimal dialysate volume**:**

2.2.1 Optimal dialysate volume should be aimed for target between 1,200-1,400 ml/m^2 in supine position for children two years and older.

2.2.2 Children less than the age of 2 years, optimal dialysate volume should be aimed for target between 600–900 ml/m^2.

2.2.3 This optimal fill volume should only be considered as a maximum target and not a requirement to achieve adequacy of dialysis.

2.2.4 The prescribed fill volume should not be too small in order to avoid functional hyperpermeability, neither be too large in order to avoid complications such as pain, dyspnea, hydrothorax, hernia formation,gastroesophageal reflux , and loss of Ultrafiltration by enhanced lymphatic drainage.

2.3 Intraperitoneal pressure (IPP):

2.3.1 It can be used as helpful guide to assess the amount of fill volume tolerated in children and infants.

2.3.2 It should not exceed 18 cm H_2O for children and <10 cm H_2O for infants.

2.4 Dwell time determination:

2.4.1 A dwell time close to 1 hour for automated peritoneal dialysis (APD) exchanges appears to be a reasonable initial prescription in children.

2.4.2 The dwell time choice needs to be adapted to the patient's condition, peritoneal membrane transport characterstics, the residual renal function, and the main goal of the treatment.

2.5 Choice of PD fluid:

2.5.1 A peritoneal dialysate fluid (PDF) with the lowest glucose concentration should be used first.

2.5.2 The use of more biocompatible PDFs should be considered for all children in chronic PD, particularly infants and young children.

2.5.3 Icodextrin containing PDFs can be an option as last fill in those with inadequate ultrafiltration, but their use should be with more caution in infants because of potential hyponatremia and rebound hypoglycemia.

2.5.4 The use of Amino acids containing PDFs has a limited beneficial role in improving nutritional status and there routine uses should be discouraged .

GUIDELINE (3) : PRESERVATION OF RESIDUAL KIDNEY FUNCTION

Measures to preserve residual kidney function (as defined by residual urine output more than 100 ml/day) need to be adopted including prescribed dose of PD, use of diuretics to maintain urine output, use of Angiotensin Converting Enzymes Inhibitors (ACEIs) and Angiotensin II Receptors Blockers (ARBs), prevention of nephrotoxic injuries such as contrast agents and nephrotoxic drugs and avoidance of dehydration.

GUIDELINE (4) : PERITONEAL DIALYSIS ADEQUACY

4.1 PD adequacy is defined as the minimum dialysis dose below which a significant morbidity and mortality occur .

4.1.1 Appropriate growth and development in children should be the most important measure of PD adequacy, together with nutritional status, good electrolytes and acid-base control, appropriate fluid status and solutes clearance both residual and peritoneal.

4.1.2 Nutritional status, Growth and development should be assessed every three months in older children and at least every month in children below two years.

4.1.3 Assessment of school progress should be incorporated on development assessment and should be done annually.

4.1.4 Biochemical and hematological parameters should be monitored every six weeks in older children and at least monthly in children less than two years.

4.1.5 An individualized regular adjustment of PD prescription should be undertaken based on these measures.

4.1.6 Adequate PD prescription should achieve adequate solute Clearance and Ultrafiltration.

4.2 Solute Clearance**:**

4.2.1 Prescribed PD dose and residual kidney function should be measured 4-6 weeks after starting PD and 6 monthly thereafter. It can be considered more frequently if clinically indicated such as after peritonitis (after minimum of four weeks),

deterioration of residual kidney function, or if there are major changes in PD prescription.

4.2.2 Either weekly Kt/V $_{urea}$ or weekly creatinine clearance can be used to assess the delivered PD dose adequacy.

4.2.2.1 Weekly Kt/V $_{urea}$ is a parameter indicates the patient's solute clearance of urea (K) during a 7-day period (t), normalized to the body's volume (V) of urea distribution (Table 1& 2), with both clearance and the volume of distribution expressed in liters.

4.2.2.2 Weekly Creatinine clearance (K_{creat}) is another clearance measure that is calculated and expressed in liter /1.73 m^2 BSA for a 7-day period using a 24 hour urine collection for urine Creatinine clearance and 24 hour dialysate drain collection for peritoneal Creatinine clearance.

4.2.3 A minimum delivered PD dose should be a total peritoneal and urine small solute clearance of weekly Kt/V $_{urea}$ of 1.7 or weekly creatinine clearance of 50 l/1.73 m^2

4.2.4 When both adequacy parameters cannot be reached together, Kt/V $_{urea}$ should be used as minimum adequacy parameter rather than K_{creat}.

Weight (kg) \ Height (cm)	50	54	58	62	66	70	74	78	82	86	90	94	98	102	106	110	114
2	1.6	1.7	1.8	1.9													
3	1.9	2.1	2.2	2.4													
4	2.2	2.4	2.6	2.8	3.0												
5	2.4	2.7	2.9	3.1	3.3												
6	2.6	2.9	3.1	3.4	3.6	3.9	4.1										
7	2.8	3.1	3.4	3.6	3.9	4.2	4.4	4.7	4.9								
8	2.9	3.2	3.5	3.9	4.1	4.4	4.7	5.0	5.3	5.5	5.8						
9				4.0	4.4	4.7	5.0	5.3	5.6	5.9	6.2	6.5	6.7				
10				4.2	4.6	4.9	5.2	5.6	5.9	6.2	6.5	6.8	7.1	7.4	7.7		
11				4.4	4.8	5.1	5.5	5.8	6.2	6.5	6.8	7.1	7.5	7.8	8.1	8.4	8.7
12				4.5	4.9	5.3	5.7	6.0	6.4	6.8	7.1	7.5	7.8	8.1	8.5	8.8	9.1
13								6.3	6.6	7.0	7.4	7.8	8.1	8.5	8.8	9.2	9.5
14								6.5	6.9	7.3	7.7	8.0	8.4	8.8	9.2	9.5	9.9
15								6.7	7.1	7.5	7.9	8.3	8.7	9.1	9.5	9.9	10.2
16								6.8	7.3	7.7	8.1	8.6	9.0	9.4	9.8	10.2	10.6
17											8.4	8.8	9.2	9.7	10.1	10.5	10.9
18											8.6	9.0	9.5	9.9	10.4	10.8	11.2
19											8.8	9.3	9.7	10.2	10.6	11.1	11.5
20											9.0	9.4	9.9	10.4	10.9	11.3	11.8

Table 1a :Male(2-20kg) Total Body Water (L) Normograms (adopted from NKF KDOQI 2006 update.

Weight (kg) \ Height (cm)	106	110	114	118	122	126	130	134	138	142	146	150	154	158	162	166	170	174	178	182	186	190
20	10.9	11.3	11.8	12.3	12.7	13.2	13.6	14.0	14.5	14.9	15.3	15.7										
22	11.4	11.9	12.4	12.8	13.3	13.8	14.3	14.7	15.2	15.7	16.1	16.6										
24	11.8	12.3	12.9	13.4	13.9	14.4	14.9	15.4	15.9	16.4	16.8	17.3	17.8	18.3	18.7							
26	12.2	12.8	13.3	13.9	14.4	15.0	15.5	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5							
28	12.6	13.2	13.8	14.4	14.9	15.5	16.0	16.6	17.1	17.7	18.2	18.7	19.3	19.8	20.3	20.8	21.3					
30	13.0	13.6	14.2	14.8	15.4	16.0	16.6	17.1	17.7	18.3	18.8	19.4	19.9	20.5	21.0	21.6	22.1					
32	13.3	14.0	14.6	15.2	15.8	16.5	17.1	17.7	18.3	18.8	19.4	20.0	20.6	21.2	21.7	22.3	22.9	23.4	24.0			
34	13.6	14.3	15.0	15.6	16.3	16.9	17.5	18.2	18.8	19.4	20.0	20.6	21.2	21.8	22.4	23.0	23.6	24.2	24.7			
36	13.9	14.6	15.3	16.0	16.7	17.3	18.0	18.7	19.3	19.9	20.6	21.2	21.8	22.4	23.1	23.7	24.3	24.9	25.5	26.1	26.6	
38	14.2	14.9	15.7	16.4	17.1	17.8	18.4	19.1	19.8	20.4	21.1	21.8	22.4	23.0	23.7	24.3	24.9	25.6	26.2	26.8	27.4	
40			16.0	16.7	17.4	18.1	18.8	19.5	20.2	20.9	21.6	22.3	23.0	23.6	24.3	24.9	25.6	26.2	26.9	27.5	28.1	28.8
42			16.3	17.0	17.8	18.5	19.2	20.0	20.7	21.4	22.1	22.8	23.5	24.2	24.9	25.5	26.2	26.9	27.5	28.2	28.8	29.5
44			16.6	17.3	18.1	18.9	19.6	20.4	21.1	21.8	22.6	23.3	24.0	24.7	25.4	26.1	26.8	27.5	28.2	28.8	29.5	30.2
46			16.8	17.6	18.4	19.2	20.0	20.8	21.5	22.3	23.0	23.8	24.5	25.2	26.0	26.7	27.4	28.1	28.8	29.5	30.2	30.9
48			17.1	17.9	18.7	19.5	20.3	21.1	21.9	22.7	23.5	24.2	25.0	25.7	26.5	27.2	27.9	28.7	29.4	30.1	30.8	31.5
50			17.3	18.2	19.0	19.8	20.7	21.5	22.3	23.1	23.9	24.7	25.4	26.2	27.0	27.7	28.5	29.2	30.0	30.7	31.5	32.2
52						20.1	21.0	21.8	22.6	23.5	24.3	25.1	25.9	26.7	27.5	28.2	29.0	29.8	30.6	31.3	32.1	32.8
54						20.4	21.3	22.1	23.0	23.8	24.7	25.5	26.3	27.1	27.9	28.7	29.5	30.3	31.1	31.9	32.7	33.4
56						20.7	21.6	22.5	23.3	24.2	25.0	25.9	26.7	27.6	28.4	29.2	30.0	30.8	31.7	32.4	33.2	34.0
58						20.9	21.8	22.8	23.7	24.5	25.4	26.3	27.1	28.0	28.8	29.7	30.5	31.4	32.2	33.0	33.8	34.6
60						21.2	22.1	23.1	24.0	24.9	25.8	26.7	27.5	28.4	29.3	30.1	31.0	31.8	32.7	33.5	34.4	35.2
62						21.4	22.4	23.3	24.3	25.2	26.1	27.0	27.9	28.8	29.7	30.6	31.5	32.3	33.2	34.0	34.9	35.7
64						21.7	22.6	23.6	24.6	25.5	26.4	27.4	28.3	29.2	30.1	31.0	31.9	32.8	33.7	34.5	35.4	36.3
66									24.8	25.8	26.8	27.7	28.6	29.6	30.5	31.4	32.3	33.2	34.1	35.0	35.9	36.8
68									25.1	26.1	27.1	28.0	29.0	30.0	30.9	31.8	32.8	33.7	34.6	35.5	36.4	37.3
70									25.4	26.4	27.4	28.4	29.3	30.3	31.3	32.2	33.2	34.1	35.1	36.0	36.9	37.8
72									25.6	26.6	27.7	28.7	29.7	30.7	31.6	32.6	33.6	34.5	35.5	36.4	37.4	38.3
74									25.9	26.9	27.9	29.0	30.0	31.0	32.0	33.0	34.0	34.9	35.9	36.9	37.8	38.8
76									26.1	27.2	28.2	29.3	30.3	31.3	32.3	33.3	34.4	35.3	36.3	37.3	38.3	39.3
78									26.3	27.4	28.5	29.5	30.6	31.6	32.7	33.7	34.7	35.7	36.7	37.7	38.7	39.7
80									26.5	27.6	28.7	29.8	30.9	31.9	33.0	34.1	35.1	36.1	37.1	38.2	39.2	40.2

Table 1b :Male(20-80kg) Total Body Water (L) Normograms (adopted from NKF KDOQI 2006 update.

Table 2a :Female(2-20kg) Total Body Water (L) Normograms (adopted from NKF KDOQI 2006 update.

Weight (kg) \ Height (cm)	50	54	58	62	66	70	74	78	82	86	90	94	98	102	106	110	114
2	2.0	2.1	2.2	2.4													
3	2.4	2.6	2.8	2.9													
4	2.8	3.0	3.2	3.4	3.6												
5	3.1	3.3	3.5	3.8	4.0												
6	3.3	3.6	3.8	4.1	4.3	4.6	4.8										
7	3.5	3.8	4.1	4.4	4.8	4.9	5.2	5.5	5.7								
8	3.7	4.0	4.3	4.6	4.9	5.2	5.5	5.8	6.1	6.4	6.6						
9				4.9	5.2	5.5	5.8	6.1	6.4	6.7	7.0	7.3	7.6				
10				5.1	5.4	5.8	6.1	6.4	6.8	7.1	7.4	7.7	8.0	8.3	8.6		
11				5.3	5.6	6.0	6.4	6.7	7.1	7.4	7.7	8.1	8.4	8.7	9.0	9.3	9.6
12				5.4	5.8	6.2	6.6	7.0	7.3	7.7	8.0	8.4	8.7	9.1	9.4	9.7	10.0
13								7.2	7.6	8.0	8.3	8.7	9.1	9.4	9.8	10.1	10.4
14								7.4	7.8	8.2	8.6	9.0	9.4	9.7	10.1	10.5	10.8
15								7.6	8.0	8.5	8.9	9.3	9.7	10.0	10.4	10.8	11.2
16								7.8	8.3	8.7	9.1	9.5	9.9	10.3	10.7	11.1	11.5
17											9.3	9.8	10.2	10.6	11.0	11.4	11.8
18											9.6	10.0	10.5	10.9	11.3	11.7	12.2
19											9.8	10.2	10.7	11.1	11.6	12.0	12.5
20											10.0	10.4	10.9	11.4	11.8	12.3	12.7

Weight (kg) \ Height (cm)	106	110	114	118	122	126	130	134	138	142	146	150	154	158	162	166	170	174	178	182	186	190
20	11.8	12.3	12.7	13.2	13.6	14.0	14.5	14.9	15.3	15.7	16.1	16.5										
22	12.3	12.8	13.3	13.7	14.2	14.7	15.1	15.6	16.0	16.4	16.9	17.3										
24	12.8	13.3	13.8	14.3	14.8	15.2	15.7	16.2	16.7	17.1	17.6	18.0	18.5	18.9	19.4							
26	13.2	13.7	14.2	14.8	15.3	15.8	16.3	16.8	17.3	17.8	18.3	18.7	19.2	19.7	20.1							
28	13.6	14.1	14.7	15.2	15.8	16.3	16.8	17.3	17.9	18.4	18.9	19.4	19.9	20.4	20.9	21.3	21.8					
30	13.9	14.5	15.1	15.7	16.2	16.8	17.3	17.9	18.4	18.9	19.5	20.0	20.5	21.0	21.5	22.0	22.5					
32	14.3	14.9	15.5	16.1	16.6	17.2	17.8	18.4	18.9	19.5	20.0	20.6	21.1	21.7	22.2	22.7	23.2	23.7	24.3			
34	14.6	15.2	15.8	16.4	17.0	17.7	18.2	18.8	19.4	20.0	20.6	21.1	21.7	22.3	22.8	23.4	23.9	24.4	25.0			
36	14.8	15.5	16.2	16.8	17.4	18.1	18.7	19.3	19.9	20.5	21.1	21.7	22.3	22.8	23.4	24.0	24.5	25.1	25.6	26.2	26.7	
38	15.1	15.8	16.5	17.1	17.8	18.4	19.1	19.7	20.3	21.0	21.6	22.2	22.8	23.4	24.0	24.6	25.1	25.7	26.3	26.9	27.4	
40			16.8	17.4	18.1	18.8	19.5	20.1	20.7	21.4	22.0	22.7	23.3	23.9	24.5	25.1	25.7	26.3	26.9	27.5	28.1	28.6
42			17.0	17.7	18.4	19.1	19.8	20.5	21.1	21.8	22.5	23.1	23.8	24.4	25.0	25.7	26.3	26.9	27.5	28.1	28.7	29.3
44			17.3	18.0	18.7	19.5	20.2	20.9	21.5	22.2	22.9	23.6	24.2	24.9	25.5	26.2	26.8	27.4	28.1	28.7	29.3	29.9
46			17.5	18.3	19.0	19.8	20.5	21.2	21.9	22.6	23.3	24.0	24.7	25.3	26.0	26.7	27.3	28.0	28.6	29.3	29.9	30.5
48			17.8	18.5	19.3	20.0	20.8	21.5	22.3	23.0	23.7	24.4	25.1	25.8	26.5	27.2	27.8	28.5	29.2	29.8	30.5	31.1
50			18.0	18.8	19.6	20.3	21.1	21.8	22.6	23.3	24.1	24.8	25.5	26.2	26.9	27.6	28.3	29.0	29.7	30.4	31.0	31.7
52						20.6	21.4	22.1	22.9	23.7	24.4	25.2	25.9	26.6	27.4	28.1	28.8	29.5	30.2	30.9	31.6	32.2
54						20.8	21.6	22.4	23.2	24.0	24.8	25.5	26.3	27.0	27.8	28.5	29.2	29.9	30.7	31.4	32.1	32.8
56						21.1	21.9	22.7	23.5	24.3	25.1	25.9	26.6	27.4	28.2	28.9	29.7	30.4	31.1	31.9	32.6	33.3
58						21.3	22.1	23.0	23.8	24.6	25.4	26.2	27.0	27.8	28.5	29.3	30.1	30.8	31.6	32.3	33.1	33.8
60						21.5	22.4	23.2	24.1	24.9	25.7	26.5	27.3	28.1	28.9	29.7	30.5	31.3	32.0	32.8	33.5	34.3
62						21.7	22.6	23.4	24.3	25.2	26.0	26.8	27.7	28.5	29.3	30.1	30.9	31.7	32.4	33.2	34.0	34.8
64						21.9	22.8	23.7	24.6	25.4	26.3	27.1	28.0	28.8	29.6	30.4	31.3	32.1	32.9	33.6	34.4	35.2
66									24.8	25.7	26.5	27.4	28.3	29.1	30.0	30.8	31.6	32.4	33.2	34.1	34.9	35.7
68									25.0	25.9	26.8	27.7	28.6	29.4	30.3	31.1	32.0	32.8	33.6	34.5	35.3	36.1
70									25.2	26.1	27.0	27.9	28.8	29.7	30.6	31.5	32.3	33.2	34.0	34.9	35.7	36.5
72									25.4	26.4	27.3	28.2	29.1	30.0	30.9	31.8	32.7	33.5	34.4	35.2	36.1	36.9
74									25.6	26.6	27.5	28.4	29.4	30.3	31.2	32.1	33.0	33.9	34.7	35.6	36.5	37.3
76									25.8	26.8	27.7	28.7	29.6	30.6	31.5	32.4	33.3	34.2	35.1	36.0	36.8	37.7
78									26.0	27.0	27.9	28.9	29.9	30.8	31.7	32.7	33.6	34.5	35.4	36.3	37.2	38.1
80									26.2	27.2	28.1	29.1	30.1	31.1	32.0	33.0	33.9	34.8	35.7	36.7	37.6	38.5

Table 2b :Female(20-80kg) Total Body Water (L) Normograms (adopted from NKF KDOQI 2006 update.

4.3 Ultrafiltration:

4.3.1 Adequate Ultrafiltration (UF) is a fundamental goal when writing a PD prescription.

4.3.2 Recommended optimal blood pressure aim should be less than 90th percentile for age, sex and height.

4.3.3 Anuric patient with daily UF less than 750 ml/1.73m^2 should be closely monitored for signs of hypervolemia and measures to improve UF should be considered such as icodextrin use with possible future shifting to HD if these measures failed.

4.3.4 Peritoneal membrane transport characteristics:

4.3.4.1 It should be assessed 4-6 weeks after starting of PD, annually or when clinically indicated using Peritoneal Equilibration Test (PET), and their result should be used in prescription modification (Figure 1).

4.3.4.2 PET test is typically performed using a 4 hours dwell volume of 1000-1100 ml/BSA (or prescribed fill volume in infants) with 2.27 or 3.86% dialysate concentration. Higher concentration will provide more information about Ultrafiltration capacity.

4.3.4.3 Based on PET test result, peritoneal membrane characterized to be high, high average, low average or low transporter.

4.3.4.4 High or high average transporter tend to have poor UF and prescription should be adjusted to optimize UF using larger volume, shorter dwelling time, sometimes higher glucose dialysate (avoiding chronic 3.86% use), icodextrin use, diuretics to preserve residual kidney function.

4.3.4.5 Low or low average transporter tend to have appropriate UF with poor solute clearance, therefore measures to optimize clearance should include long dwell time, last fill dwell,1-2 day time exchanges, if these measures failed a dialysis modality switch can be considered.

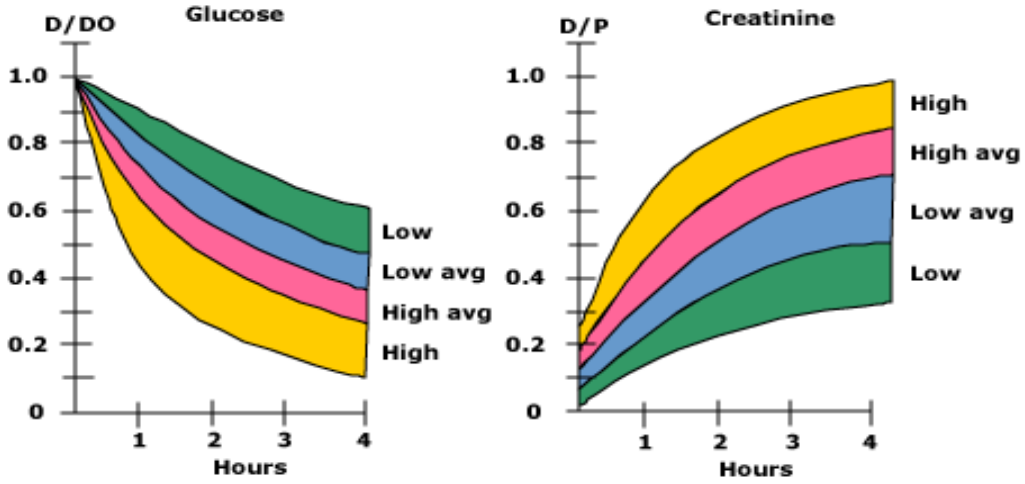


Figure 1: PET Test (adopted from Up to Date)

SUGGESTED READINGS

1. Colin T.White. Manjula Gowrishankar . Janusz Feber . Verna Yiu. Canadian Association of Pediatric Nephrologists (CAPN) and Peritoneal Dialysis Working Group, Clinical practice guidelines for pediatric peritoneal dialysis, Pediatr Nephrol (2006) 21: 1059–1066.
2. Aleksandra M. Zurowska & Michel Fischbach & Alan R. Watson & Alberto Edefonti & Constantinos J. Stefanidis & on behalf of the European Paediatric Dialysis Working Group, Clinical practice recommendations for the care of infants with stage 5 chronic kidney disease (CKD5), Pediatr Nephrol (2013) 28: 1739–48.
3. Clinical practice guidelines for peritoneal dialysis adequacy, American Journal of Kidney Diseases, Vol 48, No 1, Suppl 1 (July), 2006: pp S99-S102.
4. Fischbach M, Terzic J, Dangelsar C, Schneider P, Roger ML, Gersert J (1998) Effect of position on intraperitoneal pressure and peritoneal permeability in children. Pediatr Nephrol 12:311–314.
5. Michel Fischbach, Celine Dheu, Laure Seugé–Dargnies, and Jean François Delobbe Adequacy of peritoneal dialysis in children: consider the membrane for optimal prescription, Peritoneal Dialysis International, Vol. 27 (2007), Supplement 2.
6. Michel Fischbach & Bradley A. Warady, Peritoneal dialysis prescription in children: bedside principles for optimal practice, Pediatr Nephrol (2009) 24:1633–1642.
7. Claus Peter Schmitt & Sevcan A. Bakkaloglu & Günter Klaus & Cornelis Schröder & Michel Fischbach, Solutions for peritoneal dialysis in children: recommendations by the European Pediatric Dialysis Working Group; Pediatr Nephrol, July 2011, volume 26, issue 7; 1137-1147.
8. Cornelis H. Schröder, The choice of dialysis solutions in pediatric chronic peritoneal dialysis: guidelines by an ad hoc european committee, Peritoneal Dialysis International, Vol. 21, pp. 568–574
9. Dr Lesley Rees, Dr Sally Feather, Dr Rukshana Shroff, Peritoneal dialysis clinical practice guidelines for children and adolescents, BAPN Peritoneal Dialysis Clinical Practice Guideline, Accepted January 2008.
10. Clinical practice guidelines for peritoneal dialysis adequacy, American Journal of Kidney Diseases, Vol 48, No 1, Suppl 1 (July), 2006: pp S117-S121.
11. Wim van Biesen, Olof Heimburger, Raymond Krediet3, Bengt Rippe, Vicenzo Lamilia, Adrian Covic, Raymond Vanholder and for the ERBP working group on peritoneal dialysis, Evaluation of peritoneal membrane characteristics: a clinical advice for prescription management by the ERBP working group, Nephrol Dial Transplant (2010).

CHAPTER 8 PD CATHETER STANDARD CARE IN CHILDREN

GUIDELINE (1) PERITONEAL CATHETER TYPES
GUIDELINE (2) SURGICAL TECHNIQUE ISSUES
GUIDELINE (3) PREOPERATIVE PD CATHETER INSERTION CARE
GUIDELINE (4) POST OPERATIVE PD CATHETER INSERTION CARE

Successful PD is dependent on the placement of a reliable access. The main function of a peritoneal dialysis catheter is to permit consistent bidirectional flow of dialysate without extraordinary effort or undue discomfort.

GUIDELINE (1) : PERITONEAL CATHETER TYPES

1.1 The use of a Tenckhoff-type catheter in all ages of pediatric patients on PD is recommended.

1-2 Double-cuff catheters can be used in children more than 3 kg where the external cuff can be placed 2–3 cm from the exit site.

1-3 Use of a swan neck catheter in children should be left to the discretion of the individual PD center.

1-4 PD catheter which has a curled intraperitoneal segment is preferred to be used in pediatric dialysis.

GUIDELINE (2) : SURGICAL TECHNIQUE ISSUES

2-1 Exit-site should be oriented either downward (preferred) or laterally .

2-2 Exit site is preferred to be in the right side to preserve left side for future gastrostomy tube insertion if needed.

2-3 The tip of the PD catheter should be placed, whenever possible, in the pelvis.

2-4 Prophylactic omentectomy is preferred during PD catheter insertion.

2-5 Inspection and prophylactic closure of process vaginalis if open should be attempted during PD catheter insertion.

GUIDELINE (3) : PREOPERATIVE PD CATHETER INSERTION CARE

3-1 All children who have been assessed by the Nephrologists and PD nurse and found to be suitable for peritoneal dialysis treatment must be admitted to the hospital for insertion of a peritoneal dialysis catheter.

3-2 Prophylactic measures are indicated before PD catheter including:

3-2-1 All children should receive preoperative and, when appropriate, postoperative antibiotics with the insertion of a PD catheter. The first choice should be multiple doses of intravenous cephalosporins (first dose 3 h pre-insertion) with the second choice being one dose of vancomycin given at least 12 h prior to the catheter insertion in patients with little or no residual renal function.

3-2-2 To consider Bactroban or Gentamisin ointment to nose BID for 5 days every month for those patients with positive nose culture for staphylococcus aureus.

3-2-3 Consider giving Saline enema 10-20 ml/kg till abdomen is cleared the day before the surgery or the night before.

GUIDELINE (4) : POST OPERATIVE PD CATHETER INSERTION CARE

4-1 An X-ray KUB is routinely taken to check placement of the catheter.

4-2 PD nurse must flush the peritoneal catheter immediately post operatively using in and out exchanges of dialysate 10- 20 mls /kg until the dialysate is clear.

4-3 If the catheter is not to be used immediately, the catheter should be flushed weekly using dialysis solution 10-20ml/kg with heparin 500 IU per liter of dialysis solution to maintain catheter patency. Small dialysate volumes in the supine position can be used if dialysis is required earlier.

4-4 Only PD nurses may perform post operative care of the exit site on new catheter.

4-5 First dressing is routinely done by the PD nurse on 7^{th} day .The maximum recommended time to continue sterile dressing is 7- 10 days.

4-6 Exit sites should be washed daily or every other day with antibacterial soap or an antiseptic (either povidone iodine or chlorhexidine). Hydrogen peroxide should be avoided for routine care.

4-7 Patient or caregiver should start training as soon as possible after insertion of the catheter.

4-8 Time to start peritoneal dialysis post catheter insertion should be left to the center with a reasonable waiting of 10–14 days before starting elective dialysis in order to allow for maximum wound healing. If initiation of dialysis is required within 7 days post-catheter insertion, initial low volumes with 500 ml/BSA should be used.

SUGGESTED READINGS

1. Colin T. White. Manjula Gowrishankar .Janusz Feber. Verna Yiu . Canadian Association of Pediatric Nephrologists (CAPN) and Peritoneal Dialysis Working Group. Clinical practice guidelines for pediatric peritoneal dialysis, Pediatr Nephrol (2006) 21: 1059–1066.
2. Watson AR, Gartland C, on behalf of the European Peritoneal Dialysis Working Group (2001) Guidelines by an ad hoc European Committee for elective chronic peritoneal dialysis in pediatric patients. Perit Dial Int 21:240–244.
3. Sojo ET, Bisigniano L, Grosman M, Bailez M (1997) Ten years of experience with CAPD catheters. In: Fine RN, Alexander SR, Warady BA (eds) CAPD and CCPD in children, 2nd edn. Kluwer Academic, Boston, pp 263–279.
4. Gokal R, Alexander SR, Ash S, Chen TW, Danielson A, Holmes C, Joffe P, Moncrief J, Nichols K, Piraino B, Prowant B, Slingeneyer A, Stegmayr B, Twardowski Z, Vas S (1998) Peritoneal catheters and exit-site practices toward optimal peritoneal access: 1998 update. Perit Dial Int 18:11–33.
5. Schaefer F, Klaus G, Muller-Wiefel DE, Mehls O, and the Mid- European Pediatric Peritoneal Dialysis Study Group (MEPPS) (1999) Current practice of pediatric peritoneal dialysis in children: results of a longitudinal study. Perit Dial Int 19(Suppl 2):S445–S449.
6. NAPRTCS2004 Report.http://www.spitfire.emmes.com/study/ped/resources/annlrept2004.pdf

CHAPTER 9 NUTRITION IN PEDIATRIC PERITONEAL DIALYSIS

INTRODUCTION

Abnormalities of nutrition status are common problems in children on chronic peritoneal dialysis (PD) and source of significant morbidity and mortality. Normal nutrition status is defined as maintenance of normal body composition (and, in children, growth). The term that is now preferred for abnormalities of nutrition status in CKD is "protein–energy wasting" (PEW), which indicates a state of decreased body protein mass and fuel reserves (body protein and fat mass); "cachexia" indicates the severe form of PEW.

Goals of Nutrition Therapy in Pediatric dialysis patient

1. Maintain adequate intake for optimal macro and micronutrient status.
2. Optimize growth and development.
3. Avoid uremic toxicity, metabolic imbalances, and renal bone disease.
4. Reduce risk of chronic morbidities and mortality in adulthood.

GUIDELINE (1) : INDICATORS FOR ADEQUATE NUTRITION

1.1. Normal growth.
1.2. Normal serum albumin.

GUIDELINE (2) : PARAMETERS TO BE MONITORED

2.1. Dietary intake (3 days record or recall).
2.2. Estimated dry weight-for-age percentile (% ile) /standard deviation score(SDS).
2.3. Height-for-age %ile/SDS and growth velocity.
2.4. Body mass index (BMI) for height-age %ile or SDS(age at which child`s height would be at the 50^{th} percentile).
2.5. Head circumference-for-age %ile/SDS (<3yrs).

GUIDELINE (3) : NUTRIENT NEEDS IN PD PATIENTS

There is no standard Renal Diet. Individualized dietary recommendations are determined based on eGFR, diagnoses, age, sex, protein and energy status, growth parameters, fluid status, protein-wasting and oral motor skills.

3.1 Calories: 100% Estimated Energy Requirements (EER) for chronological age.
3.2 Protein : 100% Dietary Reference Intake (DRI) + dialytic losses (Losses range from 0.15-0.3 g/kg depending on age).
3.3 Fluid and Electrolytes: Individualize therapy.
3.4 Infants may require supplemental Na, K, and fluid.
3.5 Sodium and fluid restriction for hypertensive or anuric children.
3.6 Phosphorus: limit to 100% DRI (80% DRI when elevated).
3.7 Maximum Ca intake: 150% DRI [diet + binders] for children on dialysis due to risk of soft tissue calcifications.
3.8 Add a daily water soluble vitamins supplement.

3.8.1 B Vitamins: B1,B2,B5,B6,B12,Biotin,Folic Acid.
3.8.2 Vitamin C : supplement no more than 100mg/day.
3.9 Fat soluble vitamins.
3.9.1 Vitamin A: Do not supply as it is not removed on dialysis and there is a risk of hypervitaminosis A.
3.9.2 Vitamin E: Supply 100% DRI as it has a role in decreasing oxidative stress, and decreased risk of CVD.
3.9.3 25-OH Vitamin D: monitor levels once yearly; if level <30ng/L, supplement with ergocalciferol.
3.10 Active Vitamin D: supplement alphacalcidol /calcitriol when PTH above 2-3 folds the normal blood values.
3.11 Supplemental nutritional support should be considered when usual intake fails to meet EER or child not achieving expected rates of weight gain/growth.
3.12 Formulas may need to be calorically concentrated for oliguric or anuric children using nutritional modulars (Polycose, Protifar, Duocal, Microlipid, MCT oil).
3.13 Enteral feeding (nasogatric tube or gastrostomy)is recommended for younger children if their growth is not satisfactory.
3.14 Formula Options in Infants:
3.14.1 Breast milk is ideal due to low Potential renal solute load (PRSL) and low electrolytes content.
3.14.2 High calorie and low phosphate milk.

Table 1. Age Specific Protein Guidelines for PD

Age (yrs)	Protein (g/kg/d)
0-0.5	1.8
0.6-1.0	1.5
1-3	1.3
4-13	1.1
14-18	1.0

Table 2. Dietary Reference Intakes for Calcium (mg/d)

Age (years)	Calcium DRI (mg/day)
Infant 0-6 months	210 mg
Infant 7-12 months	270 mg
Children 1-3 years	500 mg
Children 4-8 years	800 mg
Ages 9-18 years	1300 mg
Ages 19-30 years	1000 mg

Table 3. Dietary References Intakes of Phosphorous in Children (3)

Age (years)	Phosphorous DRI (mg/day)
0-0.5	100

0.5-1	275
1-3	460
4-8	500
9-18	1250

Limit intake to 80% of DRI when PTH and/or phosphorous is eleveated

Table 4. Formula Options: Children and Adolescents

Formula	Caloric Concentration	Features
Nepro	1.8 kcal/ml	High Protein, low Lytes
NovasourceRenal	2 kcal/ml	High Protein, low Lytes
Suplena	1.8 kcal/ ml	Low Protein, low Lytes
Renalcal	2 kcal/ml	Electrolyte Free
Renastart	1 kcal/ml	Only Pediatric renal
kindergen	1 kcal/ml	Only Pediatric renal

Formula 1. Estimating Kcals Absorbed from PD

1- Multiply total dialysate volume (24 hours) x concentration of dextrose solution (1.5%, 2.5%, or 4.25%) = Total grams of dextrose

2- Multiply total grams of dextrose by estimated absorption (40% for CCPD; 43% +/- 15% absorbed for acute PD in critical care setting)

3- Multiply grams dextrose by 3.4 kcal/gram

SUGGESTED READINGS

1. Edefonti A, Mastrangelo A, Paglialonga F (2009), Assessment and monitoring of nutrition status in pediatric peritoneal dialysis patients, *Perit.Dial.Int.* 29 Suppl 2: S176-S179

2. Chaturvedi S, Jones C (2007), Protein restriction for children with chronic renal failure, *Cochrane.Database.Syst.Rev.* CD006863

3. Noordzij M, Korevaar JC, Boeschoten EW, Dekker FW, Bos WJ, Krediet RT (2005), The Kidney Disease Outcomes Quality Initiative (K/DOQI) Guideline for Bone Metabolism and Disease in CKD: association with mortality in dialysis patients, *Am.J.Kidney Dis.* 46: 925-932

4. Podel J, Hodelin-Wetzel R, Saha DC, Burns G (2000), Glucose absorption in acute peritoneal dialysis, *J.Ren Nutr.* 10: 93-

CHAPTER 10 INFECTIOUS COMPLICATIONS OF PEDIATRIC PERITONEAL DIALYSIS

GUIDELINE (1) : PREVENTION MEASURES

1.1 For early catheter care please refer to Guidelines of PD catheter standard care in children.

1.2 For chronic exit-site care, it is recommended that topical antibiotic (Mupirocin, gentamicin) to be applied daily to the peritoneal catheter exit site.

1.3 It is recommended to give prophylactic antibiotic before invasive dental procedures or before procedures involving the gastrointestinal or genitourinary tract to lower the risk of peritonitis.

1.4 To reduce the risk of fungal peritonitis, it is recommended the use of oral nystatin or fluconazole at the time of antibiotic administration to PD.

1.5 For patients going to have gastrostomy :

1.5.1 The PD catheter exit site should be placed as far as possible from an gastrostomy site.

1.5.2 The gastrostomy placement should preferentially take place either before or at the time of PD catheter placement.

1.5.3 It is recommended to withhold PD for few days after gastrostomy placement.

GUIDELINE (2) : DIAGNOSIS OF PERITONITIS & EMPIRIC THERAP

2.1 Peritonitis should be considered in the presence of fever, abdominal pain and or cloudy peritoneal effluent.

2.2 The cloudy peritoneal effluent should be sent for cell count, differential count, and culture.

2.3 The effluent should be centrifuged, and the resulting sediment be cultured or blood culture bottles should be used as an alternative way of culture technique.

2.4 It is recommended that an empiric diagnosis of peritonitis be made if the effluent white blood cell count is greater than 100/mm^3, and at least 50% of the WBCs are polymorphonuclear leukocytes.

2.5 It is recommended that the center-specific antibiotic susceptibility pattern should help to guide the selection of empiric antibiotic therapy.

2.6 For treating peritonitis, the antibiotics should be administered by the intraperitoneal route.

2.7 For the empiric treatment of peritonitis, it is suggested to start intraperitoneal cefepime as monotherapy.

2.8 First-generation cephalosporin combined with ceftazidime or an aminoglycosides if cefepime is not available .

2.9 It is recommended to add an intraperitoneal glycopeptide to cefepime, or replace a first-generation cephalosporin with an intraperitoneal glycopeptide, if the center-specific resistance rate of S. aureus isolates to methicillin or oxacillin exceeds 10% or if the patient has a history of MRSA.

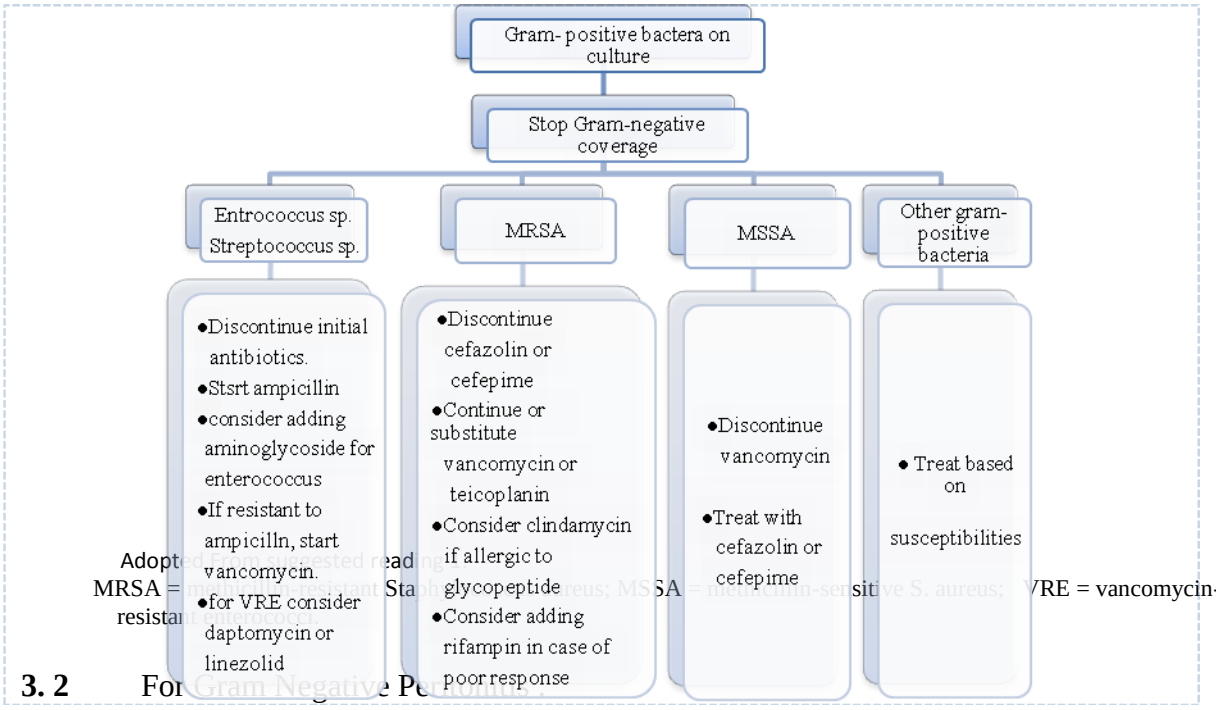
GUIDELINE (3) : MODIFICATION OF THERAPY

3.1 For Gram Positive Peritonitis :

3.1.1 It is recommended to continue cefepime or cefazolin when the gram-positive bacteria identified. Ceftazidime and aminoglycosides should be discontinued.

3.1.2 In patients with S. aureus or coagulase-negative Staphylococcus who have a delayed response to initial therapy (>72 hours), It is recommended to add rifampin.

3.1.3 The length of therapy is recommended to be 3 weeks for Staphylococcus aureus , 2- 3 weeks for Enterococcus species and 2 weeks for Coagulase-negative staphylococci &Streptococcus species.



Adopted from suggested reading
MRSA = methicillin-resistant Staphylococcus aureus; MSSA = methicillin-sensitive S. aureus; VRE = vancomycin-resistant enterococci.

3. 2 For Gram Negative Peritonitis

3.2.1 To guide the post-empiric antibiotic selection, use the susceptibility data.

3.2.2 It is recommended to discontinue empiric glycopeptide therapy (vancomycin or teicoplanin).

3.2.3 If the gram-negative bacteria are susceptible to empiric cefepime or ceftazidime, it is recommended to use either one as a single agent unless a Pseudomonas species is identified.

3.2.4 If an aminoglycoside is used for empiric treatment, It is recommended to discontinue the aminoglycoside after the species and susceptibilities of the bacteria are known, unless a Pseudomonas species is identified

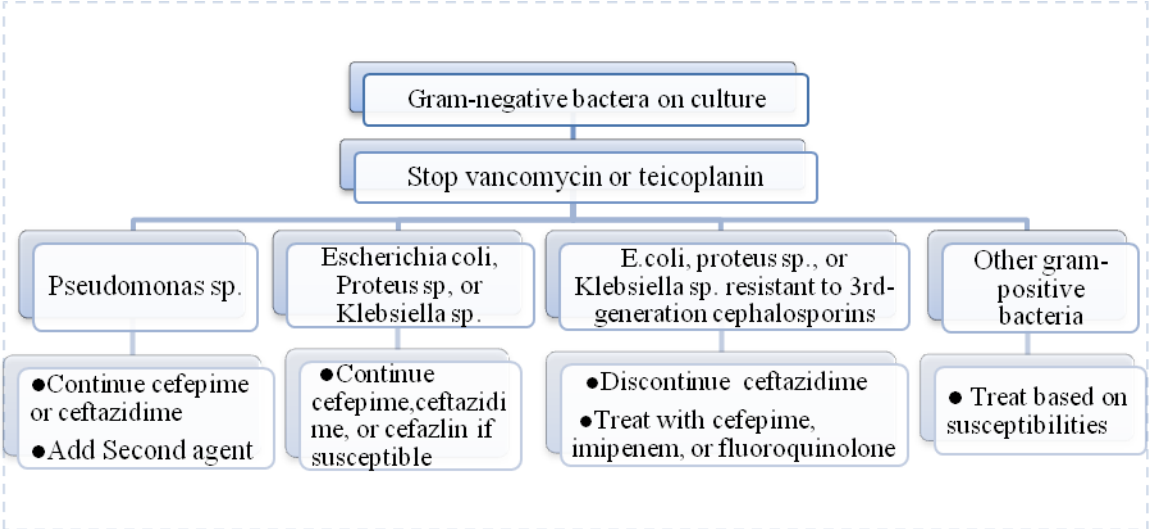
3.2.5 It is recommended to add second agent with a different mechanism of action, when Pseudomonas species is identified

3.2.6 Length of the therapy

3.2.6.1 Three weeks for Pseudomonas species ,Stenotrophomonas maltophilia and extended beta-lactamase organisms(Escherichia coli, Klebsiella species)

3.2.6.2 Two to three weeks for Enterobacter, Citrobacter, Serratia, Proteus and Acinetobacter species.

3.2.6.3 Two weeks for Escherichia coli or Klebsiella species.



Adopted From suggested reading 1

3. 3 For Culture Negative Peritonitis :

3.3.1. If the initial cultures remain sterile at 72 hours and if signs and symptoms of peritonitis are improved, continue on empiric antibiotic therapy that have been started consisting of ceftazidime combined with either cefazolin or a glycopeptides for 2 weeks.

3.3. 2. Administration of an aminoglycoside should be discontinued at 72 hours in patients with a sterile culture and clinical improvement.

3.3.3. Patients with culture-negative peritonitis who fail to demonstrate clinical improvement after 72 hours should undergo a repeat PD effluent cell count, differential, and culture .If the culture continues to be negative and if the PD effluent cell count has not improved, special culture techniques should be used for the isolation of unusual or fastidious organisms, including fungi, mycobacteria, and Legionella.

3. 4 For Fungal Peritonitis **:**

3.4.1. If fungi are identified by gram stain or culture of peritoneal effluent, therapy should consist of treatment with an antifungal agent and early catheter removal.

3.4.2 After catheter removal, antifungal agent be administered for 2 weeks or longer after complete resolution of the clinical symptoms.

GUIDELINE (4) : ADJUNCTIVE THERAPY

4.1 In patients with significant abdominal discomfort reduce the peritoneal fill volume during the initial 24–48 hours of therapy, other than that peritoneal Dialysis prescription shouldn`t be changed.

4.2 It is recommended to administer 500 IU/L heparin until complete resolution of dialysate cloudiness.

GUIDELINE (5) : RELAPSING PERITONITIS

5.1 It has been defined as peritonitis that recurs with the same organism as in the preceding episode, according to antibiotic susceptibilities within 4 weeks of completion of antibiotic treatment.

5.2. It is suggested to start empiric therapy as above mention then post-empiric antibiotic

therapy of relapsing peritonitis be guided by in vitro susceptibility results, choosing an antibiotic other than cefazolin.

5.3 It is recommended to remove the PD catheter as soon as peritonitis is controlled by antibiotic therapy in the setting of relapsing peritonitis associated with a persistent or recurrent tunnel infection.

GUIDELINE (6) : PD CATHETER REMOVAL AND REPLACEMENT

6.1 It is recommended to remove the PD catheter for refractory bacterial peritonitis, fungal peritonitis, patients with an exit-site or tunnel infection in conjunction with peritonitis with the same bacteria (particularly S. aureus and P. aeruginosa), except Coagulase-negative staphylococci.

6.2 It is suggested to remove and replace PD catheter simultaneously for a refractory exit-site or tunnel infection.

6.3 It is suggested a minimum period of 2 – 3 weeks between PD catheter removal and insertion of a new PD catheter for fungal, enteric, and refractory bacterial peritonitis.

GUIDELINE (7) : TREATMENT OF CATHETER RELATED INFECTION

7.1. It is suggested that oral antibiotic therapy of uncomplicated catheter exit-site infections be initiated upon receipt of culture results and susceptibilities, and that treatment be continued for a minimum of 2 weeks and for at least 7 days after complete resolution of the infection.

7.2. Treatment for at least 3 weeks is recommended for exit-site infections caused by S. aureus or P. aeruginosa.

7.3 It is suggested that antibiotic therapy for catheter tunnel infections be initiated after culture and susceptibility results have been obtained unless signs of severe infection or a history of S. aureus or P. aeruginosa is present, for which initiation of empiric therapy should be considered.

7.4 The route of antibiotic administration can be oral, intraperitoneal, or intravenous unless MRSA is the causative agent, in which case intraperitoneal or intravenous glycopeptide therapy is indicated. Treatment duration should be 2 – 4 weeks.

Antibiotic Dosing Recommendations[a] for the Treatment of Peritonitis

Antibiotic type	Therapy type: Continuous[b] Loading dose	Continuous[b] Maintenance dose	Intermittent[b]
Aminoglycosides (IP)[c]			
Gentamicin	8 mg/L	4 mg/L	
Netilmycin	8 mg/L	4 mg/L	Anuric: 0.6 mg/kg
Tobramycin	8 mg/L	4 mg/L	Non-anuric: 0.75 mg/kg
Amikacin	25 mg/L	12 mg/L	
Cephalosporins (IP)			
Cefazolin	500 mg/L	125 mg/L	20 mg/kg
Cefepime	500 mg/L	125 mg/L	15 mg/kg
Cefotaxime	500 mg/L	250 mg/L	30 mg/kg
Ceftazidime	500 mg/L	125 mg/L	20 mg/kg
Glycopeptides (IP)[d]			
Vancomycin	1000 mg/L	25 mg/L	30 mg/kg; repeat dosing: 15 mg/kg every 3–5 days
Teicoplanin[e]	400 mg/L	20 mg/L	15 mg/kg every 5–7 days
Penicillins (IP)[c]			
Ampicillin	—	125 mg/L	—
Quinolones (IP)			
Ciprofloxacin	50 mg/L	25 mg/L	—
Others			
Aztreonam (IP)	1000 mg/L	250 mg/L	—
Clindamycin (IP)	300 mg/L	150 mg/L	—
Imipenem–cilastin (IP)	250 mg/L	50 mg/L	—
Linezolid (PO)	<5 Years: 30 mg/kg daily, divided into 3 doses 5–11 Years: 20 mg/kg daily, divided into 2 doses ≥12 Years: 600 mg/dose, twice daily		
Metronidazole (PO)	30 mg/kg daily, divided into 3 doses (maximum: 1.2 g daily)		
Rifampin (PO)	10–20 mg/kg daily, divided into 2 doses (maximum: 600 mg daily)		
Antifungals			
Fluconazole (IP, IV, or PO)	6–12 mg/kg every 24–48 h (maximum: 400 mg daily)		
Caspofungin (IV only)	70 mg/m^2 on day 1 (maximum: 70 mg daily)	50 mg/m^2 daily (maximum: 50 mg daily)	

IP = intraperitoneally; IV = intravenously; PO = orally.
[a] Adapted from Li *et al.* (7), *The Renal Drug Reference Guide* (171), and Taketomo *et al.* (172).
[b] For continuous therapy, the exchange with the loading dose should dwell for 3–6 hours; all subsequent exchanges during the treatment course should contain the maintenance dose. For intermittent therapy, the dose should be applied once daily in the long-dwell, unless otherwise specified.
[c] Aminoglycosides and penicillins should not be mixed in dialysis fluid because of the potential for inactivation.
[d] In patients with residual renal function, glycopeptide elimination may be accelerated. If intermittent therapy is used in such a setting, the second dose should be time-based on a blood level obtained 2–4 days after the initial dose. Re-dosing should occur when the blood level is <15 mg/L for vancomycin, or <8 mg/L for teicoplanin. Intermittent therapy is not recommended for patients with residual renal function unless serum levels of the drug can be monitored in a timely manner.
[e] Teicoplanin is not currently available in the United States.

Adopted From suggested reading 1

SUGGESTED READING

1. Consensus guidelines for the prevention and treatment of catheter-related infections andperitonitis in pediatric patients receiving peritoneal dialysis: 2012 update. Warady BA, et al. Perit Dial Int. 2012
2. Prevention of peritonitis in children: emerging concepts. Bakkaloglu SA, et al. Perit Dial Int. 2009
3. Dialysis-associated peritonitis in children.Chadha V, et al. Pediatr Nephrol. 2010
4. Treatment for peritoneal dialysis-associated peritonitis.Wiggins KJ,et al. Cochrane Database Rev. 2008
5. Fungal peritonitis in children on peritoneal dialysis.Raaijmakers R, et al. Pediatr Nephrol. 2007
6. Prevention and treatment of peritoneal dialysis-associated peritonitis in pediatric patients.Klaus G, et al. Perit Dial Int. 2005
7. Meeting the challenges of infection in pediatric peritoneal dialysis. Warady BA, et al. Perit Dial Int. 2012.

CHAPTER 11 NON INFECTIOUS COMPLICATIONS IN PEDIATRIC PERITONEAL DIALYSIS

GUIDELINE (1) : ABDOMINAL PAIN

1.1 Preventive measures should be applied to avoid increase intra-peritoneal pressure (IPP)As per recommendations.

1.2 Clinical evaluation of abdominal pain in PD patient should include both dialysis related factors(catheter type, catheter location, cycler malfunction,dialysate temperature and concentration) and non- dialysis related factors(pancreatitis, peptic ulcer, peritoneal calcifications ..).

1.3 Pain on inflow can be treated by Addition of lidocaine to solution bags prior to infusion, use of physiologic dialysate fluids and shifting to a lower dialysate concentrate.

1.4 Pain on outflow usually resolve with time .Pain may be lessened by incomplete drainage (eg, tidal dialysis).Occasionally, catheter repositioning or removal may be necessary.

GUIDELINE (2) : HERNIA

2.1 Hernia is not uncommon peritoneal dialysis complication that needs prevention and early discovery with proper management. Preventive measures include:

2.1.1 Detection and repair of preexisting hernias before insertion of the catheter.

2.1.2 Detection and repair of a patent processes vaginalis by the surgeon during insertion of the peritoneal catheter.

2.1.3 Use of paramedian incision for catheter insertion is preferred.

2.1.4 Peritoneography or laparoscopic inspection for hernia during catheter insertion is Preferred.

2.1.5 Hernia repair is preferred to small infants who need peritoneal dialysis.

2.2 Careful clinical examination to discover hernia is mandatory with each clinical visit in post catheter period insertion.

2.3 Patients who develop a hernia after the initiation of PD should undergo elective hernia repair.

2.4 Peritoneal dialysis can be resumed within several days of the hernia repair, using low volume, supine, rapid cycling PD with gradual reinstitution of the former PD regimen in the subsequent two to four weeks period.

2.5 Provide Hemodialysis(HD) backup if needed in patients with no residual renal function.

GUIDELINE (3) : PERITONEAL DIALYSATE LEAK

3.1 High risk patients(poor wound healing , high IPP) should be identified before the procedure.

3.2 Preventive measures include:

3.2.1 Paramedian incision for PD catheter insertion and using double cuff catheter are recommended.

3.2.2 PD initiation is preferred to be delayed 10-14 days after catheter insertion unless it is urgently indicated to start dialysis.

3.3 Clinical evaluation should include possibility of internal leak and edema (hydrocele, scrotal swelling, labial edema, thigh edema with peau d orange skin appearance..).

3.4 External leak can be diagnosed by high glucose content of the leaking fluids from exit site by using dextrostix.

3.5 Water contrast image, peritoneal scintigraphy, CT scan and MRI can be used to confirm internal leak. PD catheter should be replaced if diagnosis is confirmed.

3.6 Most external leaks can be managed with same conservative measures used in treatment of hernia(Guideline 2.4), consider PD catheter replacement if these measures failed.

3.7 Prophylactic antibiotic is preferred.

GUIDELINE (4) : ULTRAFILTRATION FAILURE IN PERITONEAL DIALYSIS

It is defined as Ultrafiltration < 750ml/1.73 m^2 in anuric patient

4.1 Catheter obstruction is a major cause and should be evaluated and managed well.

4.1.1 Eliminate kinks, remove clamp on transfer set, examine PD portion hidden by clothing and dress.

4.1.2 Dislodge blockage by infusing dialysate or normal saline using moderate pressure(push and pull maneuver), disconnect procedure if patient notes pain or cramp.

4.1.3 Correct constipation and treat urine retention if present.

4.1.4 Evaluate catheter position by KUB x-ray(AP- Lateral views).

4.1.5 In case of fibrin related obstruction:

4.1.5.1 Flush with heparinised dilysate (500 unit/l)is recommended.

4.1.5.2 Catheter suction should be avoided.

4.1.5.3 Instill recombinant tissue plasminogen activator (tPA) 1 mg/mL up to 8 mLs (1-8 mg) as per catheter volume with dwell for 1-2 hours. Dose can be repeated and use of overnight dwell was reported to be safe and effective.

4.1.5.4 Catheter manipulation: fibrin clots can be loosened and subsequently removed by Fogarty catheter manipulation.

4.1.5.5 Invasive intervention(open surgical, laparoscopic, interventional radiologic) is needed if there is catheter tip migration, adhesion, omental wrap or other surgical conditions.

4.2 Evaluate and manage any possible dialysate leak as per recommendations.

4.3 Low Ultrafiltration in stable growing PD patient with good urine output is expected and does not need intervention.

4.4 Fill volume and dwell time should be individualized for each patient as per recommendations.

4.5 Tidal dialysis and long dwell with Icodextoin are recommended as therapeutic measures.

4.6 Increasing dialysate concentration should be minimized.

GUIDELINE (5) : HYDROTHORAX

5.1 Hydrothorax should be suspected clinically when there is a progressive dyspnea and/or orthopnea with unilateral or bilateral pleural effusion occurred after starting PD.

5.2 The pleural fluid is transudative and has a high glucose and lactate concentration.

5.3 Nuclear Imaging study can be used for the diagnosis.

5.4 Treatment

5.4.1 Patients with severe respiratory distress may require thoracocentesis for initial relief of symptoms.

5.4.2 PD should be temporarily discontinued or, at a minimum, changed to a modality associated with lower peak IPP (lower volumes or nocturnal intermittent PD).

5.4.3 Pleurodesis with Talc, Triamcinolone, Autologous blood, Tetracycline derivatives and fibrin glue may be attempted in case of recurrence. Use of video-assisted thoracoscopic pleurodesis is recommended.

5.4.4 Surgical repair via a limited thoracotomy is indicated if pleurodesis fails. Repair of diaphragmatic hernia should be done if present.

5.4.5 Alternatively, patients may elect to transfer to HD.

GUIDELINE (6) : HEMOPERITONEUM

Hemoperitoneum is a rare complication in children.

6.1 Trauma by a PD catheter is the commonest cause .It needs conservative treatment in most of the cases that include intra-peritoneal heparin(500 unit/l) to prevent catheter clot, frequent exchange and using room temperature dialysate fluid.

6.2 Other rare causes include menstruation, peritoneal calcification, pancreatitis, post abdominal surgery…) that are needed to be addressed and managed accordingly.

GUIDELINE (7) : ENCAPSULATED SCLEROSING PERITONITIS(ESP)

7.1 PD patient presented with non specific symptoms (intestinal obstruction, abdominal pain ,vomiting …) is suspected clinically to have ESP if he is on dialysis for more than 5years and there is either active or history of peritonitis and/or Ultrafiltation failure.

7.2 Computer tomography (CT)is the diagnostic imaging modality of choice and should be done in suspected patient.

7.3 There are no preventive measures for ESP patient with long PD (> 8years).

7.4 Routine pre-emptive switching to haemodialysis after a specified time on PD is not recommended. PD should usually be discontinued after diagnosis of EPS with transfer to haemodialysis. However, in symptomatically mild cases, patient life expectancy and quality of life should be considered in individual cases before switching to haemodialysis

7.5 EPS is a complex condition, whose optimal management requires multidisplinary team compose of nephrologist,PD nurse,intensivist,dietitian ,radiologist and surgeon with experience in EPS surgery

7.5.1 Early dietetic referral and careful monitoring of nutritional status, with nutritional support is essential

7.5.2 There is no clear evidence to support a recommendation for the use of any medical therapy for treating the inflammatory and fibrotic features of EPS. Corticosteroids, immunosuppressants and tamoxifen have been used, and may be tried at the physician's discretion

SUGGESTED READING

1. Pediatric Dialysis by a. Warady ,MD,publisher Springer,second edition,2012, ISBN 978-1-4614-0721-8

2. International Society of Peritoneal Dialysis guidelines. http://www.ispd.org/lang-en/treatmentguidelines/guidelines
3. Campos rp, Chula dc, Riella mc. Complications of the Peritoneal access and their management. Contrib Nephrol 2009; 163:183
4. Rinaldi s, Sera f, Verrina e, etal. Chronic Peritoneal dialysis catheters in children: a fifteen-year experience of the Italian Registry of Pediatric chronic peritoneal dialysis. Perit Dial Int 2004; 24:481.
5. Annabelle etal, Chronic peritoneal dialysis in children,Uptodate March 2014
6. Rebvecca etal ,Noninfectious complications of peritoneal dialysis catheters, Uptodate March 2014
7. Fischbach m, Measurement of hydrostatic intraperitoneal pressure: a useful tool for the improvement of dialysis dose prescription. Pediatr Nephrol. 2003 Oct;18(10):976-80. EPUB 2003 jul 26
8. Martin etal, Dialysate leaks in Peritoneal Dialysis,Seminars in dialysis,14(1) 2001
9. Susie Q etal, Hydrothorax: pleural effusion associated with peritoneal dialysis, Perit Dial Int. 2010 jan-feb;30(1):
10. UK encapsulating peritoneal sclerosis,clinical practice guidelines july 2009

CHAPTER 12 PERITONEAL DIALYSIS FOR ACUTE KIDNEY INJURY IN CHILDREN

GUIDELINE (1) PERITONEAL DIALYSIS AS A MODE OF RENAL REPLACEMENT THERAPY IN ACUTE KIDNEY INJURY
GUIDELINE (2) ACCESS AND FLUID DELIVERY FOR ACUTE PD IN CHILDREN
GUIDELINE (3) PERITONEAL DIALYSIS SOLUTIONS FOR ACUTE PD IN CHILDREN
GUIDELINE (4) PRESCRIPTION OF ACUTE PD IN CHILDREN

GUIDELINE(1) : PERITONEAL DIALYSIS AS A MODE OF RENAL REPLACEMENT THERAPY IN ACUTE KIDNEY INJURY

Peritoneal dialysis is a suitable modality for renal replacement therapy in acute kidney injury in children .

GUIDELINE (2) : ACCESS AND FLUID DELIVERY FOR ACUTE PD IN CHILDREN

2.1 Tenckhoff catheter inserted by a surgeon in the operating theatre is recommended as the optimal choice for PD access.

2.2 Close manual PD delivery systems and Automated Peritoneal Dialysis should be used in treating children with AKI. However, APD cannot be used when fill volumes are too small .

GUIDELINE (3) : PERITONEAL DIALYSIS SOLUTIONS FOR ACUTE PD IN CHILDREN

3.1 The composition of the acute peritoneal dialysis solution should include Dextrose in a concentration designed to achieve the target Ultrafiltration.

3.2 Serum concentrations of electrolytes should be measured 12 hourly for the first 24 hours and daily once stable .More frequent monitoring may be required if clinically indicated.

GUIDELINE (4) : PRESCRIPTION OF ACUTE PD IN CHILDREN

4.1 The initial fill volume should be limited to 10-20 ml/kg to minimize the risk of dialysate leakage; a gradual increase in the volume to approximately 800 – 1,100 ml/m^2 may be reached as tolerated by the patient. Fill volumes should not exceed 800 ml/m^2 in patients < 2 years .

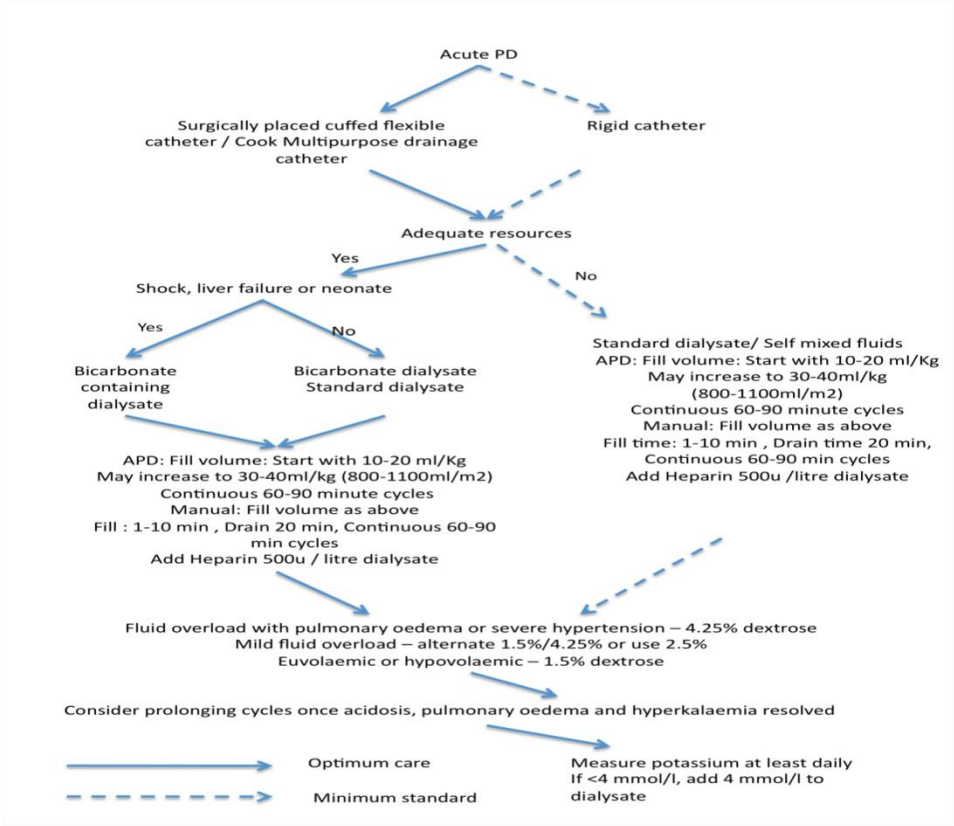
4.2 The initial exchange duration, including inflow, dwell and drain times, should generally be every 60-90 minutes; gradual prolongation of the dwell time can be done as fluid and solute removal targets are achieved. In neonates and small infants, the exchange duration may need to be reduced to achieve adequate Ultrafiltration.

4.3 Close monitoring of total fluid intake and output is mandatory with a goal to achieve and maintain normotension and euvolemia. Higher dialysate Dextrose concentration can be used if clinically indicated.

4.4 Acute PD should be continuous throughout the full 24 hour period for 1-3 days.

4.5 There may be enhanced clearance of medication in acute PD and it is recommended that doses are adjusted accordingly and where possible levels should be monitored.

Figure P4: Suggested paediatric dosing algorithm: adopted from:cullis etal,



adopted from:cullis etal, ISPD guideline:peritoneal dialysis for acute kidney injury (under press)

SUGGESTED READING

1- Sorof JM, Stromberg D, Brewer ED, Feltes TF, Fraser CD Jr. Early initiation of peritoneal dialysis after surgical repair of congenital heart disease. Pediatr Nephrol 1999; 13:641–5

2- Warady BA, Bunchman T. Dialysis therapy for children with acute renal failure: survey results. Pediatr Nephrol. 2000 Nov;15(1-2):11-3.

3- Flynn JT, Kershaw DB, Smoyer W, Brophy PD, McBryde KD, Bunchman T. Peritoneal dialysis for manafement of paediatric acute renal failure. Perit Dial Int 2001;21:390–394

4- Bonilla-Felix M. Peritoneal dialysis in the paediatric intensive care unit setting: techniques, quantitations and outcomes. Blood Purif 2013; 35(1-3):77-80

5- Dell'Aquilla R, Chiaramonte S, Rodighiero MP, Spano E, Di Loreto P, Kohn CO, et al. Rational choice of peritoneal dialysis catheter. *Perit Dial Int 2007 Jun;27 Suppl2:S119-25*

6- Rusthoven E, Van de Kar NA, Monnens LA, Schröder CH. Fibrin glue used successfully in peritoneal dialysis catheter leakage in infants and small children with acute renal failure treated with PD. *Peritoneal Dial Int. 2004 May-Jun;24(3):287-9*

7- Ansari N. Peritoneal dialysis in renal replacement therapy for patients with acute kidney injury. *Int J Nephrol*; doi: 10.4061/2011/739794. June 8, 2011, E-pub.

8- Mishra OP, Gupta AK, Pooniya V, et al. Peritoneal dialysis in children with acute kidney injury: a developing country experience. *Perit Dial Int* 2012; 32:431-436.

9- Fischbach M. Peritoneal dialysis prescription for neonates. *Perit Dial Int* 1996; 16(Suppl 1): S512-S514.

10- Askenazi D. Evaluation and management of critically ill children with acute kidney injury. *Curr Opin Pediatr* 2011; 23:201-207.

PART 3
PERITONEAL DIALYS UNIT
CHAPTER 13 PERITONEAL DIALYSIS UNIT SETTING & STANDARDS

The main steps needed to establish a successful PD program are summarized in tables 1-3. These include the establishment and equipment of PD unit, continuous education and training of medical and nursing staff, and patient education program including enrollment process on PD therapy.

(1) Education and Training Section

(a) The setup of a PD unit should include well equipped and furnished unit (table 3)

(b) Patients and their relatives/family/companion should be educated in this section and introduced to PD modality of treatment and its different techniques, and how to implement it and avoid its possible complications (table 4). Re-training and evaluation of the performance of PD patients should be attested following the completion of their training and before being discharged to perform at home a specific PD modality safely and independently.

(2) Therapeutic Section This section should be well equipped and furnished to allow for treating at least 2-3 patients at a time. (table 3).

(3) Nursing Office

(a) This section should be furnished well. Table 3 .

(b) The PD nurse could use this space to organize the necessary PD work, and assess the adequacy of PD treatment by measuring the Kt/v and clearances, and assess the transporter type of the peritoneal membrane of PD patients following the performance of peritoneal equilibration test (PET) by using PD software programs.

(4) Store

The PD unit should allow for a storage space for daily/weekly storing and accessing the required quantities of different types of PD solutions, catheters, dressing gauze, gloves, syringes, needles and other daily used materials that are usually used for PD training and treatment.

Education and Training Program for Medical Staff

Continuous education and training of the medical staff (nurses and nephrologists) on the modalities of peritoneal dialysis is an essential part of the success of the PD program. This process should be planned to precede the establishment of a PD unit. Potential PD nurses should receive a theoretical background course on anatomy and physiology, modalities, applications, procedures, indications and advantages and disadvantages of peritoneal dialysis (table 5). They should also receive adequate practical exposure in other well established PD unit/centers under the supervision of experienced staff. Equally important, nephrologists should undergo theoretical and practical re-training courses and receive encouragement and support to consider PD treatment as an important and possible first modality option for management of ESRD patients. Policies and procedures should be established and continuously updated according to International Society of Peritoneal Dialysis (ISPD) guidelines/recommendations and clinical practice guidelines.

The medical staff educational and training program should include implementation of major courses provided by PD provider companies. Educationa and training should also be supported

by providing educational materials including internet PD web sites, brouchers, booklets, video/DVD programs and PD scientific journals.

Patient Education/Training and Enrollment Process on PD Therapy

In general, there are no selective criteria for acceptance of patients on APD. This is in particular the case for patients transferred from HD due to failed vascular access or cardiovascular instability, as there is no other possible choice. Patients approaching ESRD, who were under the care of nephrologists/renal team, should be assessed according to clinical suitability of each patient for PD treatment and, when needed, the availability of caregiver. The list of preparation and enrollment of a potential PD patient includes the following steps:

1) Following the diagnosis of CKD, and in particular when a patient has approached stage 4 (GFR <30 ml/min), the patient should be referred to a counseling clinic for explanation of the possible future options of available renal replacement therapy including PD as a priority modality of treatment. APD treatment option should also be provided for patients with failed hemodialysis, mainly due to vascular access problem, and offered as well for patients on regular hemodialysis following adequate explanation of its techniques and advantages.

2) Once a symptomatic patient has reached ESRD and accepted PD treatment as a preferred treatment modality, a referral and assessment forms should be filled by the treating nephrologist and sent to the PD unit.

3) Teaming up with an experienced general surgeon is an important step for PD catheter insertion and postsurgical care, and together with the support of a dietitian, psychiatrist and social worker PD treatment can be a successful modality.

4) The patient should then be examined by the nephrology team and by the general surgeon to ensure the absence of any contraindication for PD catheter insertion in the peritoneal cavity.

5) The nursing staff at PD unit should welcome the patient and family/relatives and explain to them, in simple terms, the modality of PD treatment using posters and educational materials in order to achieve full understanding and acceptance of treatment and obtain informed consent. These measures should include the following:

a) Explanation of the normal function of the kidney and how it can be substituted by PD dialysis.
b) The basic principles of manual and automated PD treatment.
c) Demonstration and explanation of the need of PD dialysis disposables.
d) Assessment of patient educational standard during introduction and explanation of PD treatment. This would enable the PD team to a better approach to patient.
e) Correction of misconception about PD treatment modality.
f) Improve the confidence of patient with PD and alleviate any concerns or worries by assuring the patient/family their ability to perform these simple but important procedure steps.

g) Introduce the potential PD patient to an already existing PD patient(s) to ask questions and boost confidence.
h) Introduce patients and their relative/companion to different techniques of PD modality; how it can be implemented and how to avoid its possible complications. This could be achieved by watching PD educational programs recorded on videocassette or DVD, using plastic models with samples of PD catheters, PD solutions and demo PD machine, and by providing patient with educational leaflets/booklets, handouts and posters on PD treatment.
i) Re-training and evaluation of the performance of PD patients should be attested following the completion of their training and before being discharged to perform at home a specific PD modality safely and independently.

6) Once agreed and accepted the PD option, the patient should be referred to a general surgeon (who's part of the renal/PD team) to insert the double-cuff standard silicon Tenckhoff PD catheter after securing a consent and the willingness of patient and/or his family/relative to be trained on procedure and techniques of PD treatment.patient will be managed as per clinical guidelines recommendations of PD catheter insertion.

7) During this period, the patient/family or relatives should be trained on how to perform the steps of PD procedure.

8) It is advisable to allocate a specific qualified and trained nurse to train the patient; as involvement of more than one nurse may create confusion to patient. During the training stage, it is aimed that patient should learn and practice the technical skills under the supervision of qualified and experienced PD nurse. It is important to continuously assess the ability of patient to perform the technique independently, correct his/her mistakes, use simple language and allow for any simple or possibly thought stupid question. The training schedule should be planned over one week period. Once the renal team is confident that the patient is capable of practicing the procedure independently under aseptic conditions, then he/she can be discharged home to continue self-treatment.

9) Scheduled home visits are mandatory to check on performing PD procedure in a specific setting and in aseptic environment. Furthermore, it is equally important to ensure the availability of suitable room to store PD solutions. Patient at home should be supplied with the telephone number of the PD unit and PD nurse for any possible need for consultation. PD patients should also be scheduled for monthly hospital visit to PD clinic for re-assessment of PD treatment, performance of PET and PD adequacy by measuring Kt/V. During these visits to PD clinic, the PD prescription should be adjusted according to patient's need.

10) The supply of PD solutions/machine/disposables direct to patients at their homes is vital in running a successful PD program.The advantages of home delivery system are summarized in table 5.

11) It is recommended to organize regular monthly supplies of PD solutions direct from the providing company's stores by creation and implementation of a monthly prescription/order form.

Table 1: Ten steps for implementation of PD program

1. Adequate training and reorientation of medical staff (doctors and nurses) in principles and practice of peritoneal dialysis.
2. Creation of committed and cooperative PD team (nephrologist / PD nurses / general surgeon or interventional nephrologist/social worker/psychologist/dietician).
3. A basic, but well planned, equipped and organized PD unit (including educational, training and treatment sections).
4. Establishment and regular update of detailed PD policies and procedures.
5. Early approach (in nephrology clinic) of patients with CKD (stage 4).
6. Arrangement for patients to visit the PD unit and meet PD patients.
7. Adequate pre-dialysis education and training of potential PD patients.
8. Back up support: (storage, PD solutions delivery system to patients at home, continuous education, assessment and patient retraining program).
9. Regular and continuous PD education and training of medical staff.
10. Close and continuous monitoring of the PD program: assessment and re-evaluation of clinical outcome, and adjustment of policies and procedures according to results in order to achieve the best out of the PD program.

PD: peritoneal dialysis, CKD: chronic kidney disease

Table 2: Requirements for establishing and succeeding a PD program

1. **Motivation**
   Well motivated and dedicated team is the cornerstone to a successful PD program. The team should include nephrologists, surgeons, nurses, social workers, and dietitians.
2. **Support**
   Inpatients beds, Back up HD, OPD clinic and training/education rooms.
3. **Staffing**
   Well trained medical /nursing staff to cover patients' needs on 24h basis.
4. **Finances**
   Financial support is needed for clinical, chemical, and microbiological laboratory, and reliable distribution of PD fluids to patient's homes.
5. **Training**
   A well trained and updated health team is needed to contribute to effective delivery of services. This includes doctors, nurses, and patients.
6. **Qualities of a PD nurse**
   Peritoneal dialysis nurses should have certain qualities to insure the progress and success PD program. This includes patience, consistency, flexibility, sense of humor, ability to communicate, and good judgment.
7. **Protocols**
   Each unit needs to have protocols for various procedures to ensure safe and consistent care. The required protocols include training program, treatment of infections, laboratory tests and medication, and infection control policies and procedures.
8. **Data Recording and Monitoring**
   Recording and monitoring morbidity and mortality rates as well as incidence of peritonitis.

PD: peritoneal dialysis, HD: hemodialysis, OPD: outpatient department.

Table 3: peritoneal dialysis unit sections

PERITONEAL DIALYSIS UNIT SECTIONS	

clinic room	training ,education room	nursing office	store room	others
- clean set out, washbasins with long tab water handle - beds and clean/sterile bed sheets, pillows and blankets, bedside tables - intravenous solutions holding stands, trolleys carrying necessary medications, sterile sets and sheets, gloves, syringes, needles and dressing gauze. - Adequate supplies of PD catheters, PD solutions of different types, concentrations and volumes. - monitoring area which should be equipped with a desk, chair, computer and cabinet for patients .	-clean set out, sofas, coffee tables, cupboard/shelves, -educational materials (handouts, posters, booklets),video cassette/DVD player, plastic models, gloves, syringes, -needles, dressing gauze -samples of PD catheters and PD solutions - demo APD machine.	-adjacent to training room - desk, chair, telephone/fax, computer and the suitable PD software programs and a printer.	PD solutions, catheters, dressing gauze, gloves, syringes, needles and other daily used materials -supplies should in sufficient amount for daily use	Patients waiting area for male and female - patients wash rooms

Table 4 : PD education programs

	Nursing education programs	Patient education programs
Responsibility	**Peritoneal dialysis program manager Nursing administration**	**Peritoneal dialysis program manager Nursing administration**
Providers	**Nephrologists,Nurse educators,PD company**	**PD nurses,nephrologists**
Topics	1. Brief history of PD 2. Anatomy of the peritoneum 3. PD kinetics 4. Factor affecting PD efficiency 5. Types of PD 6. PD catheters 7. Catheter insertion: pre and post care 8. Catheter break-in 9. Exit site care 10. Dialysis prescription 11. PD procedure 12. Patients education 13. Nursing follow up 14. Routine medications 15. Acceptable blood chemistries 16. Infectious complications of PD 17. Non-Infectious complications of PD 18. Technical problems	1. Healthy Kidneys and kidney function 2. How CAPD works 3. Exchange procedure 4. Cleanliness and Hygiene 5. Weight and Fluid Balance 6. Exit site care 7. Peritonitis 8. Diabetic patients 9. Medications 10. Maintaining supplies

Table 5: Advantages of home delivery system of PD solutions

1. Happiness, satisfaction and confidence of PD patients in their treatment modality due to the assurance of continuous and regular supply and delivery of all their needs of PD solutions and disposables to maintain their PD treatment, without their direct involvement.

2. Confidence of the PD team in the delivery system as a backup of the program.

3. Lack of need to store large quantities of PD solutions in hospital/department or PD unit stores, and hence there should be no need for creating extra space or storage area.

4. Avoidance of retained or expired PD solutions.

5. A track record of patient prescriptions and consumption.

6. Precise assessment of monthly and yearly consumption of all patients, which should result in accurate assessment of planning budget and reimbursements.

SUGGESTED READINGS:

1) Karkar A. Caring for patients with chronic kidney disease: benefits and rewards. *Int J Nephrol* 2011;639840;1-6.
2) Karkar A, Abdelrahman MR. Outcome of Patients Treated with Automated Peritoneal Dialysis: Effects of Selection of Patients. *Saudi J Kidney Dis Transplant* 2011;22(1):40-48.
3) Karkar A. The value of pre-dialysis care. *Saudi J Kidney Dis Transplant* 2011;22 (3):419-427.
4) Youmbissi TJ, Malik TQ, Abdulrahman MR, Karkar A. Simplified surgical placement of Tenckhoff catheter under local anesthesia: The Dammam Central Hospital experience. *Saudi J Kidney Dis Transplant* 2001;12 (2)175-178.
5) Youmbissi TJ, Malik TQ, Rafi A, Al Ahmad F, Sinha AK, Abdulrahman M, Karkar A. CAPD in Dammam Central Hospital, Saudi Arabia: A five-year experience. *Saudi J Kidney Dis Transplant* 2001;12 (4): 511-515.
6) Souqiyyeh MZ, Shaheen FAM. Survey of the Attitude of Physicians towards Establishing and Maintaining a Peritoneal Dialysis Program. Saudi J Kidney Dis Transpl 2006;17:355-364.
7) Souqiyyeh MZ, Al-Wakeel J, Al-Harbi A, Al-Shaebi F, Al-Kanhal F, Mousa FM, Wahdan EY, Shaheen FAM. Effectiveness of a separate training center for peritoneal dialysis patients. Saudi J Kidney Dis Transpl 2008;19(4):574-582.
8) Saudi Centre for Organ Transplantation Annual Report 2008. www.scot.org.sa
9) Lameire N, Van Biesen W, Vanholder R. The role of peritoneal dialysis as first modality in an integrative approach to patients with end-stage renal disease. Perit Dial Int 2000;20 (Suppl 2):S134-S141.
10) Burkart J. Transitions from PD are expected. Why not continue at home? Perit Dial Int 2007;27:645-646.
11) McDonald SP, Marshall MR, Johnson DW, Polkinghorne KR. Relationship between dialysis modality and mortality. J Am Soc Nephrol 2009;20:155-163.
12) Heaf JG, Lokkegaard H, Madsen M. Initial survival advantage of peritoneal dialysis relative to haemodialysis. Nephrol Dial Transplant 2002;17:112-117.
13) Venosh EF, Snyder JJ, Foley RN, Collins AJ. Mortality studies comparing peritoneal dialysis and hemodialysis: what do they tell us? Kidney Int 70:S3-S11, 2006.
14) Liem YS, Wong JB, Hunink MG, de Charro Fort, Winkelmayer WC. Comarison of hemodialysis and peritoneal dialysis survival in the Netherlands. Kidney Int 2007;71:153-158.
15) Wang AYM. The heart of peritoneal dialysis: residual renal function. Perit Dial Int 2007;27:116-124.
16) Franco MG, Lima G. Peritoneal dialysis in the elderly patients. Perit Dial Int 2007;27:S15.
17) Brown EA. Peritoneal dialysis for older people: Overcoming the barriers. Kidney Int 2008;73:S68-S71.

18) Dombros N, Dratwa M, Feriani M, et al. European best practice guidelines for peritoneal dialysis. 5 Peritoneal dialysis solutions. Nephrol Dial Transplant 2005;20(Suppl 9):ix16-ix20.

19) Frampton JE, Plosker GL. Icodextrin: a review of its use in peritoneal dialysis. Drugs 2003;63:2079-2105.

20) Kim S, Oh J, Kim S, Chung W, Ahn C, Kim SG, Oh KH. Benefits of biocompatible PD fluid for preservation of residual renal function in incident CAPD patients: a 1-year study. Nephrol Dial Transplant 2009;2:1-11.

21) Stinghen AE, Barretti P, Pecoits-Filho R. Factors contributing to the differences in peritonitis rates between centers and regions. Perit Dial Int 2007;27(S2):S281-S285.

22) Little J, Irwin A, Marshall T, Rayner H, Smith S. Predicting a patient's choice of dialysis modality: experience in a United Kingdom renal department. Am J Kidney Dis 2001;37:981-986.

23) Jager KJ, Korevaar JC, Dekker FW, Krediet RT, Boeschoten EW. **The effect of contraindications and patient preference on dialysis modality selection in ESRD patients in The Netherlands.** Netherlands Cooperative Study on the Adequacy of Dialysis (NECOSAD) Study Group. Am J Kidney Dis 2004;43:891-899.

24) Rodd K, Wuerth D, Finkelstein FO. Progress and Barriers that Continue to Challenge the CKD Educational Process. Perit Dial Int 2006;26 (suppl 1):46A.

25) Goovaerts T, Jadoul M, Goffin E. Influence of a Pre-Dialysis Education Programme (PDEP) on the mode of renal replacement therapy. Nephrol Dial Transpl 2005;20:1842-1847.

26) Rubin HR, Fink NE, Plantinga LC. Patient ratings of dialysis care with peritoneal dialysis vs. Hemodialysis. JAMA 2004;291:697-704.

27) Juergensen E, Wuerth D, Juergensen PJ. Hemodialysis and peritoneal dialysis: patient's assessment of their satisfaction with therapy and the impact of the therapy on their lives. Clin J Am Soc Nephrol 2006;1:1191-1196.

28) Flanigan MJ, Rocco MV, Prowant B. Clinical performance measures: the changing status of peritoneal dialysis. Kidney Int 2001;60:2377-2384.

29) Badve SV, Hawley CM, Mcdonald SP, Mudge DW, Rosman JB, Brown FG, Johnson DW. Automated and continuous ambulatory peritoneal dialysis have similar outcomes. Kidney Int 2008;73:480-488.

30) Ramos Sanchez A, Madonia C, Rascon-Pacheco RA. Improved patient/technique survival and peritonitis rates in patients treated with automated peritoneal dialysis when compared to continuous ambulatory peritoneal dialysis in a Mexican PD center. Kidney Int 2008;73:S76-S80.

31) Venkataraman V, Nolph KD. Utilization of PD modalities: evolution. Semin Dial 2002;15:380-384.

32) Keshaviah P, Emerson PF, Vonesh EF, Brandes JC. Relationship between body size, fill volume, and mass transfer area coefficient in peritoneal dialysis. J Am Soc Nephrol 1994;4:1820-1826 (B).

33) Michels MW, Verduijn M, Boeschoten EW, Dekker FW, Krediet RT, for the NECOSAD Study Group. Similar survival on automated peritoneal dialysis and continuous ambulatory peritoneal dialysis in a large prospective cohort. Clin J Am Soc Nephrol 2009;4:943-949.

34) Rodriguez-Carmona A, Perez FM, Garcia FT, et al. A comparative analysis on the incidence of peritonitis and exit-site infection in CAPD and automated peritoneal dialysis. Perit Dial Int 1999;19:253-258.

35) Huang JW, Hung KY, Yen CJ, et al. Comparison of infectious complications in peritoneal dialysis patients using either a twin-bag system or automated peritoneal dialysis. Nephrol Dial Transplant 2001;16:604-607.

36) Davison SN, Jhangri GS, Jindal K, Pannu N. Comparison of volume overload with cycler-assisted versus continuous ambulatory peritoneal dialysis. Clin J Am Soc Nephrol 2009;4:1044-1050.

37) Mujais S, Nolph K, Gokal R, et al. Evaluation and management of ultrafiltration problems in peritoneal dialysis. International Society of peritoneal Dialysis Ad Hoc Committee on Ultrafiltration Management in Peritoneal Dialysis. Perit Dial Int 2000;20(suppl 4):S5-S21.

38) Blake PG. Advantages and disadvantages of automated peritoneal dialysis compared to continuous ambulatory peritoneal dialysis. Perit Dial Int 1999;19 (Suppl 2):S11-S14.

39) De Wit GA, Merkus MP, Krediet RT, et al. A comparison of quality of life of patients on automated and continuous ambulatory peritoneal dialysis. Perit Dial Int 2001;21:306-312.

40) Brown EA, Davies SJ, Heimburger O, et al. Adequacy targets can be met in anuric patients by automated peritoneal dialysis: baseline data from the EAPOS. Perit Dial Int 2001;21:S133-S37

41) Lameire N, Peeters P, Vanholder R, Van Biesen W. Peritoneal dialysis in Europe: an analysis of its rise and fall. Blood Purif 2006;24:107-114.

42) Finkelstein FO. Structural requirements for a successful chronic peritoneal dialysis program. Kidney Int 2006;70:S118-S121.

43) Farrington K, Rao R, Gilg J. New adult patients starting renal replacement therapy in the UK in 2005 (chapter 3). Nephrol Dial Transplant 2007; 22(Suppl 7): vii11–vii29.
44) Mehrotra R, Kermah D, Fried L, Kalantar-Zadeh K, Khawar O, Norris K, Nissenson A. Chronic peritoneal dialysis in the United States: declining utilization despite improving outcomes. J Am Soc Nephrol 2007;18:2781-2788.
45) Bernardini J, Price V, Figueiredo A. Peritoneal dialysis patient training, 2006 (ISPD guidelines/recommendations). Perit Dial Int 2006;26:625-632.
46) Kazancioglu R, Ozturk S, Yucel L, Guvenc S, Ekiz S, Dogan S. Importance of home visits in peritoneal dialysis. Dialysis & Transplantation April 2008:132-136.
47) Swiech-Bruce C. Training tool empowers elderly. Perit Dial Int 2009;29:S15.
Troidle LK, Kliger AS, Finkelstein FO. Barriers to CPD utilization in network#1, New England. Perit Dial Int 2006;26:452-457.
48) Durand PY and Verger C. The state of peritoneal dialysis in France. Perit Dial Int 2006;26:654-657.
49) Mehrotra R, Khawar O, Duong U, Fried L, Norris K, Nissenson A, Kalantar-Zadeh K. Ownership patterns of dialysis units and peritoneal dialysis in the United States: utilization and outcomes. Am J Kidney Dis 2009;1:262.
50) Diaz-Buxo JA, Crawford-Bonadio TL, St. Pierre D, Ingram KM. Establishing a successful home dialysis program. Blood Purif 2006;24:22-27.
51) Piraino B. Nurses and physicians working together. Perit Dial Int 2006;26:641-642.
52) Piraino B, Bailie GB, Bernardini J, Boeschoten E, Gupta A, Clifford Holmes, Kuijper EJ, Li PKT, Lye WC, Mujais S, Paterson D, Fontan MP, Ramos A, Schaefer F, Uttley L. ISPD guidelines/recommendations. Peritoneal dialysis-related infections. Recommendations: 2005 update. Perit Dial Int 2005;25:107-131.
53) Davies S. Clinical practice guidelines. Module 3b: Peritoneal dialysis. UK Renal Association. Third Edition, 2006 (Reformatted January 2008). www.renal.org/guidelines.
54) Bennett-Jones DN, Martin J, Barratt AJ, Duffy TJ, Naish PF, Alber GM. Prophylactic gentamycin in the prevention of early exit-site infections and peritonitis in CAPD. Adv Perit Dial 1988;4:147-150

INDEX:

R

T

U