RESIDENT ORIENTATION TO NEPHROLOGY & RENAL TRANSPLANT

St. Michael's Hospital

Fourth Edition

July 2015

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I. INTRODUCTION

Welcome to Nephrology. In addition to goals and objectives, this manual details some of the practical issues relating to your time on the nephrology ward (8CS), the consult service and the outpatient clinics. There are more detailed (and often more up to date) protocols on 8CS for many of the issues related to specific subjects in transplantation and dialysis.

Rotation Objectives: Core Medical Trainees

A) Data Gathering/Knowledge

General Nephrology

1) To understand the approach to renal failure
   - acute vs chronic
   - if acute: pre-renal, renal, post-renal
   - primary vs secondary
   - glomerular, tubular, vascular, interstitial

2) To understand the conservative management of acute renal failure

3) To understand the management of chronic renal failure
   - specific therapies (e.g. immunotherapy)
   - non-specific therapies (e.g. HTN control, RASS blockade, dietary protein intake, etc.)
   - complication therapies (e.g. diuretic therapy)

4) To understand drug therapy of hypertension and an approach to renal artery disease

5) To understand the workup of hematuria and proteinuria

6) To understand and develop an approach to common fluid electrolyte and acid base problems (hypo & hypernatremia, hypo & hyperkalemia, metabolic acidosis & alkalosis)

7) To understand the indications for dialysis, the basic concepts regarding selection of dialysis modality and the basic components of renal replacement therapies (i.e. diffusive vs. convection clearance or dialysis vs. ultra-filtration, respectively)

Renal Transplantation

- To understand the basics of renal transplantation, including indications, management of immunotherapy, mechanisms and management of rejection, and infection in an immunocompromised host, transplant ethics

B) Choice and Use of Ancillary Tests

1) To be able to perform a competent microscopic urine examination, and to understand the assessment of renal function with serum creatinine and creatinine clearance
2) To understand the indications for and complications of kidney biopsy

C) Performance under Emergency Conditions

1) Management of acute hyperkalemia
2) Management of acute poisoning e.g. Methanol, ASA
3) Management of hypertensive emergencies
4) Competence in securing temporary vascular access for haemodialysis

D) Supplementary

1) Ability to perform competent general nephrology consultation
2) Knowledge of immunology of transplantation and glomerulonephritis
3) Knowledge of renal osteodystrophy, indications for parathyroidectomy
4) Optimizing dialysis prescription for acute kidney injury in critically ill patients

Nephrology & Renal Transplantation Administrative Structure

Nephrology is part of the DIABETES COMPREHENSIVE CARE PROGRAM (DCCP). The program director is Jill Campbell (X5791) and the Medical Director of the DCCP is Dr. Jeff Zaltzman.

Nephrologists: all are available through hospital locating (416-864-5431)

DR. MARC GOLDSTEIN[1]	3-061 Shuter
DR ZIV HAREL	61 Queen 7th floor
DR. MITCH HALPERIN	Li Ka Shing
DR. KAMEL KAMEL[2]	61 Queen 9th floor
DR. PHIL. MARSDEN[10]	Li Ka Shing
DR. PHIL MCFARLANE[3,4]	61 Queen 9th floor
DR. JEFF PERL	3-060 Shuter
DR. MARTIN SCHREIBER[5]	61 Queen 9th floor
DR. RAMESH PRASAD	61 Queen 9th floor
DR. RON WALD	61 Queen 9th floor
DR. JORDAN WEINSTEIN[6]	61 Queen 9th floor
DR DARREN YUEN	Li Ka Shing 5-059
DR. JEFF ZALTZMAN[7,8,9]	61 Queen 9th Floor

1 Medical Director, Haemodialysis

2 Division Head

3,4Medical Director, Home Dialysis, Living Donor Program

5 Undergraduate Education

6 Educational Director; Core Residents

7,8,9Medical Director Transplantation, Ward Chief, Educational Director; Nephrology Trainees & Fellows, Medical Director of the Diabetes Comprehensive Care Program (DCCP)

10 DDD Nephrology, University Program Director

In Patient Nephrology/Urology/Transplantation ward: 8CCS X5097

Manager :Colleen JohnsX5293

Medical Director: Dr. J. Zaltzman

Haemodialysis Unit In-centre: located on 8CCS

Manager: Pamela Robinson X2791

Medical Director: Dr M. Goldstein X5290

Access Coordinator: Joyce Hunter X6353

Nurse Practioners: Ann Jones

Alison Thomas

Mimi Cheng

Home Dialysis: 8CCN X5794

Manager: Elizabeth Anderson X 2721

Medical Director: Dr. P. McFarlane

Unit: X5794/3848 Blackberry: 416-416-527-2632

Nurse Navigator: Mina Kashani X2387

Case Manager: Fatima Benjamin-Wong X6977

Staff Nurses: Ramona Cook, Jumi Charles, Shaniel Des Vignes, Kyla Moyer, Mary Beth Adams, Julie De La Cruz, Beth Unana

Transplant Program: 9th Floor, 61 Queen X 3665

Manager: Jonathan fetros X 7436

Medical Director: Dr. J.Zaltzman

Meriam Jayoma: Transplantation 867-8179

Galo Meliton: Transplantation 867-3677

Fernanda Shamy: Transplantation 867-3676
JennyHuckle: Transplantation 867-8040
Thelma Carino: Transplantation 867-8219
Sarah Mattock: Transplantation
Maureen Connelly: Transplantation
Tess Montana-Atin: NP Transplant (diabetes)

Social Work:
Suela Cela
Courtney Sas
Sharon Lee
Carmen Morris

Dietitians:
Carol Huang HPDU/9Q pager 685-9376
Karen Burleigh 8CC/TXP pager 685-9432

Pharmacists:
Lisa Liberatore Kidney Care Clinic KCC pager 685-0108
Diane Chong Home Dialysis
Lucy Chen Transplant/8CC

Interventional Radiology: X5886
For dialysis catheters, biopsies*, PD catheter manipulations, etc.

* for RENAL BIOPSIES Please fill out pathology biopsy form on ward an FAX, and do pre-biopsy orders. If you want the result STAT (same day) the biopsy must be done before 10:00 am, and speak to Dr. Jothy (renal pathologist X2921) in advance

Microscope for urinalysis: on 8CC and 9th floor 61 queen

Nephrology & Renal Transplantation Housestaff Responsibilities

(Education: Dr. Jordan Weinstein)

The Nephrology rotation is a combined inpatient ward, consult and ambulatory clinic experience. There is a strong teaching component. 8 am teaching sessions (Mon-Thurs),

During a One-month rotation, the 5 nephrology house staff will be divided into two teams of 3 & 2 residents. Each team will spend 2-3 weeks on the nephrology ward (8CS) and one 5-6 weeks on the consult rotation. If a house staff member is doing only one month, the choice of service may not be guaranteed as team assignments will be based on needs and vacation times.

Each team will have an attending nephrologist and a nephrology trainee as the day to day leader/teacher. (attendings for 2 week period)
Formal rounds with the attending nephrologist will take place twice weekly, usually Monday and Friday mornings, although there can be some flexibility to accommodate the schedules of the attending, fellow and housestaff.

IT IS EXTREMELY IMPORTANT THAT MORNING SIGN-OVER and EVENING SIGN-OUT TAKE PLACE WITH BOTH TEAMS PRESENT, AS THE ON-CALL RESIDENT MUST BE FAMILIAR WITH ALL WARD AND CONSULT PATIENTS. The charge nurse in dialysis (X5228) must be contacted first thing in the AM and last thing in the PM by the consult and the ward fellow to update the needs of the acute dialysis patients.

Given vacations, post-call and half-days back, it is foreseeable that the numbers on one of the teams could at times be as low as ZERO. During these times, it is expected that the teams will 'cross-cover' for each other.

During the consult month, house staff will be expected to attend ~6 ambulatory nephrology clinics. These constitute part of your evaluation.

All formal teaching rounds are organized for the entire group of housestaff.

II. IN-PATIENT WARD EXPERIENCE

Admissions to ward include patients from the hemo unit, home dialysis unit, acute transplants and transplant-related issues, nephrologists' offices and ER. **Most renal patients will be not be admitted to 8CS.** Admissions should be reserved for those patients with primarily nephrologic issues. For example, a hemodialysis patient with an acute CVA should be admitted to team medicine and followed by the nephro consult team.

All ward admissions are under the attending nephrologist for that period or under the weekend attending nephrologist. The patient will be transferred to the care of the attending at the end of the weekend or holiday.

Discharges are planned the night prior to discharge with notification of patient and nursing staff. It is of utmost importance that discharge summaries be dictated immediately upon discharge, with copies sent to family physicians, referring internists and staff. Notes regarding Transplant, Hemodialysis, Peritoneal Dialysis patients are to be dictated STAT, with copies to be sent to the respective units and most responsible physicians.

There is a daily meeting at 8:00 AM (or earlier on teaching mornings) on 8 CS of all the Nephrology Housestaff and the attending nephrologists to ensure adequate transfer of tasks and responsibilities. Bullet rounds with team and 8CS staff occur at ~09:30 every morning to highlight the plans of the day for each in-patient. Brief team/staff meetings are held as the need arises to review clinical problems or new consults. Ward rounds will be arranged at least twice weekly by attending staff.

Progress notes are required q72 hours, more frequently if patient's condition warrants should always conclude with the statement "Discussed with staff".

III. CONSULTATION EXPERIENCE

The Consult Service offers the opportunity to deal with renal or fluid and electrolyte disorders in patients who are on other services. Many consults come from the critical care units where acute kidney injury is the most likely reason for consult request. The 'Consult Opinion' is expected to be an expert opinion. Although Consults are part of the responsibility of renal trainees, they are an integral component of Internal Medicine Trainee experience on the nephrology service. Patients with acute kidney injury should be re-assessed early each day to ensure adequate planning for any dialysis needs.

Consult Rounds will be arranged at least twice weekly by attending staff.

IV. AMBULATORY PATIENT EXPERIENCE

Every week there are Outpatient Clinics that have been organized to facilitate resident participation. In addition to the other areas, resident evaluations will include a domain specific to the out-patient experience.

	Monday	Tuesday	Wednesday	Thursday	Friday
AM	**Transplant**	**KCC Clinic**		**Nephrology Clinic**	**KCC Clinic** 61 Queen 9th floor

PM	**Clinic** Dr. Prasad 61 Queen 9th floor (9:00-12:00) --- **Nephrology Clinic** Dr. Schreiber 61 Queen 9th floor (11:30-17:00)	Drs. Goldstein Harel, Wald 61 Queen 9th floor (9:00-12:00) **Nephrology Clinic** Drs. Zaltzman or Kamel 61 Queen 9th floor (9:00-12:00) --- **Nephrology Clinic** Dr Weinstein 9th flr (12:00-16:30) **Home dialysis** 8CCN-Home Dialysis Unit (12:0016:00)	**Nephrology Clinic** Kamel, Zaltzman, Perl* 61 Queen 9th floor (08:00-12:00) **Transplant Clinic** Dr. Yuen 61 Queen 9th floor (9:00-12:00) ---	Dr. Prasad or Dr. Wald 61 Queen 9th floor (8:00-12:00) **Transplant Clinic** Dr. Zaltzman 61 Queen 9th floor (09:00-12:00) **Nephrology office** Dr. Goldstein 3 Shuter (08:00-16:00) **Home Dialysis - Post Clinic Rounds** 9:15-1030 8CCS Conference Room --- **Renal Stone Clinic** Drs. Schreiber, Kamel, Weisnstein 61 Queen 9th floor (1:00-4:00)	(9:00-12:00)

PRDC = Progressive Renal Disease Clinic (pre-dialysis and chronic kidney disease)

MDCC = Multidisciplinary Diabetes Complications Clinic (diabetes, nephropathy, hypertension)

* Perl Clinic is on 3-Shuter Room 060

Each resident will be sent an e-mail from Michelle Gottwald (Dr. Schreiber's assistant) asking them when they will not be available in terms of (a) holidays,

(b) other days off, (c) ambulatory medicine clinics. Once this is available, a clinic schedule per rotation will be distributed on the first day of the rotation.

These clinics are expected to start on time, and it is expected that Residents/Fellows will be present on time. The staff person covering the clinic will communicate clinic cancellation ahead of time.

V. EDUCATION AND RESEARCH EXPERIENCE

RENAL TRAINEES

GOALS AND OBJECTIVES

1) To provide a unique exposure in the management of kidney, dialysis and renal transplant issues
2) At SMH; particular focus and learning in the following key clinical areas:
    - **Acid base/ fluid electrolytes**
    - **Renal transplantation**
    - **Hemodialysis**
    - **AKI**
    - **Nephrolithiasis**

MOH PGY4s

1 or 2 months of consult, 1month nephro/transplant ward, 2 months dialysis

½ day ambulatory nephrology clinic at either: SMH, UHN, SBMC

MOH PGY5s

Assigned to SMH based on choice (clinics, transplant, dialysis, Jr Attending)

½ day ambulatory nephrology clinic at either: SMH, UHN, SBMC

NON-MOH Clinical fellows

6 month rotation

In-patient transplant/ nephrology ward

Consult service

1 month ambulatory clinic (if available)

½ day/week ambulatory nephrology clinic with designated SMH Nephrologist

Education

Teaching rounds: 8am -9am

First week of block is orientation for Core Trainee Residents, So there will be case report on Monday AM and renal biopsy rds Tuesday AM during this week (location TBD)

All Wednesdays : Renal trainee rds at Li Ka Shing. Core Curriculum

On Non-Orientation weeks (see schedule for core trainees) Only difference is a different set of rounds for core trainees vs renal trainees on wed mornings

Wed 2-5 PM : University renal rounds for all Nephrology trainees at TGH

Call Duties :

Requests for call and vacation to Michelle Gottwald (gottwaldm@smh.ca)

1) Weekdays: Second call from home 1:2 to 1:3
2) Weekends : 1 to 2 calls per month. 2 renal trainees on call: 1 ward, 1 consult, second call with SCR resident and weekend attending nephrologist

Attending staff on weekends covers first and second and overnight HD shift for urgent issues, renal trainee covers evening (3rd shift). Trainees split duties over weekend.

B. Teaching Rounds

DAY	TIME	ACTIVITY	LOCATION
MONDAY	*8:00 – 9:00 !9:00-11:30	Morning report Ward Rounds/Consult RD Transplant clinic	8 CC 8 CC
TUESDAY	8:00 - 9:00 9:00 - 12:00 9:00 - 12:00 12:00 -16:30 12:30-16:30 12:00-16:00	Basic Science Rds/M&M/Biopsy Rounds Progressive Renal Disease Clinic Nephrology Clinic- Dr. Zaltzman Nephrology Clinic-Dr. Kamel Nephrology Clinic- Dr. Dr. Donnelly, Weinstein Home Dialysis Clinic	8 CC 61Queen 9th floor 61Queen 9th floor 61 Queen 7th floor 61 Queen 9th floor 8CCN Home Dialysis Unit
WEDNESDAY	8:00 - 9:00 8:00-9:00 9:00 - 12:00 12:00 - 13:00	Teaching Seminars (residents) Renal Trainee Teaching Rounds Nephrology Clinic Medical Grand Rounds	8 CC Li Ka Shing 2nd flr 61 Queen 9th floor 61 Queen 9th floor 61 Queen 7th floor Queen St auditorium
THURSDAY	8:00 – 9:00 8:30 - 11:00 9:15-10:3012:00 – 1:00 8:00- 12:0013:15- 16:30 13:00-14:00	Dr. Halperin Teaching Transplant Clinic Home dialysis clinic reviewq2 weeks Bench to Bedside Dr. Marsden et al. Nephrology-Dr. Goldstein, Wald Stone Prevention Clinic Home dialysis multidisciplinary education rounds	8 CC 61 Queen 9th floor 8 CC Conference room 7 CC Conference room 3 Shuter (Goldstein), 61 Queen 9th floor (Wald) 61 Queen 9th floor 8 CC Conference room
FRIDAY	8:00 - 8:30 9:00 – 12:00 16:00 -	Sign-over KCC clinic Weekend Signover	8CC ward 61 Queen 9th floor 8CC

- *on teaching days, residents should meet for sign-over at 7:45, before teaching rounds
- ** every 2 months on the third Friday of the month, rounds are Nephro-ICU joint rounds 13:00-14:00
- Bullet rounds with ward team, nurses, SW, manager etc at 9:30

C. Research

During the rotation, trainees are encouraged to take advantage of the opportunity for discussions with staff that have expertise in the different areas of nephrology. Indeed, there are numerous opportunities to get involved in various research projects of all sizes. This may involve patient centered clinical research, case reviews and chart audit type studies, basic physiology or bench type research.

The nephrologists encourage residents to participate in research activities and are happy to supervise a project. These projects could be presented at the annual St. Michael's Resident Research day (Higgin's Day) or oftentimes at national and international meetings. Special areas of interest and expertise amongst the staff are detailed below:

Dr. Goldstein	- Acid-base and electrolyte physiology, haemodialysis
Dr Harel	- Quality Control
Dr. Halperin	- Acid-base and electrolyte physiology
Dr. Kamel	- Acid-base and electrolyte physiology and renal stones
Dr. Marsden	- Molecular medicine and hypertension
Dr. McFarlane	- Diabetes, hypertension, dialysis, clinical epidemiology, health economics
Dr. Perl	- Peritoneal dialysis, general nephrology
Dr. Prasad	- Transplantation

Dr. Schrieber - Medical education/renal physiology

Dr. Wald - Acute kidney injury, hemodialysis, general nephrology

Dr. Weinstein - Medical education, e-Learning and web development

Dr. Yuen - Kidney fibrosis

Dr. Zaltzman - Transplantation

VI. HAEMODIALYSIS

The haemodialysis units are located on 8CC. The main unit on 8CC is open from Sunday 22:00 until Saturday 23:00.

An on-call dialysis nurse is available after hours and Sundays for emergency dialysis needs. If a nurse is required to come in, this decision is made with renal resident and the attending nephrologist. The nurse has been instructed to confirm with the housestaff that the attending nephrologist has been informed. He/she will verify this with you.

Most patients are dialyzed 3X/week, but some receive short daily dialysis and some receive nocturnal dialysis. The thrice weekly shifts are on Monday, Wednesday, Friday (MWF) or Tuesday, Thursday, Saturday (TTS).

All Nephrology Patients: It is of utmost importance that renal patients do not have intravenous or heparin locks inserted into the **cephalic veins** from the wrist to the shoulder. MD to make notation on initial blood work orders to avoid cephalic vein cannulation.

Resident responsibilities for chronic HD patients

Residents do **not** provide first line care for the out patient dialysis patients as there are Renal staff and Renal trainees involved in the care of these patients (see schedule on ward and in the hemo unit). Residents **are** responsible for in-patients and patients on the consultation service who are on dialysis (acute or chronic patients). Any acute dialysis needs should be brought to the attention of the charge nurse the night before or immediately to their

attention at the beginning of the morning schedule (07:30) This includes writing the orders, monitoring therapies and signing over issues to the MD responsible for the care of the patients upon the discharge of the patient to the outpatient setting. In addition, admissions from the dialysis unit will be directed to the residents.

Residents are needed to respond to acute issues for dialysis patients if the assigned nephrologist has already left after seeing the patients. These visits are to be completed in consultation with the nephrologist assigned to that patient (see schedule on the ward and in the hemo unit). Ideally the hemo nurse will first contact the MD assigned to the patient who may then contact the housestaff to assist in the care of the patient if an onsite visit of the MD is required. However, if the nurse feels the issue is of such an urgent nature, the hemo nurse will contact the housestaff directly. In all such cases, the MD responsible for the patient should be informed either immediately or first thing in the morning.

Dialysis Orders

A written consent must be obtained by the physician for line insertions and for haemodialysis treatments.

HBsAg should be done and ideally the results known prior to the first treatment as HBsAg positive patients are isolated for their dialysis treatment. If a patient may need dialysis in the foreseeable future, order the HBsAg early.

Dialysis orders need to be written in advance (a day ahead if possible) for all acute patients and for all chronic haemodialysis patients admitted to hospital.

For stable chronic in-patients, orders can be written once per week unless changes are required. Note: for historical reasons, the dialysate is often referred to as the "bath".

Orders are written in the usual order section of the chart and include:

1) **Dialyser**: usually Xenium 210
2) **Time**: for chronic patients 4 hours is typical (very uremic patients may need more frequent but short dialysis runs performed daily to avoid the dialysis disequilibrium syndrome)
3) **Blood pump speed (BPS)**; maximum as tolerated. Conventionally dialyzed patients typically use a blood pump speed between 300-450 ml/ min. Patients receiving nocturnal hemodialysis (with treatment times over 6 hours) may have a slower blood pump speed (200-350 mL/min). Acute and/or very uremic patients may need slower speeds (ex. ~200 ml/min) initially to avoid the dialysis disequilibrium syndrome)
3) **[Na^+] in dialysate:** usually 140 mmol/L, but can use 'ramped sodium" ([Na^+] starting at 145- to 160 mmol/L, reducing to 140 over first 3 hours of treatment). Ramped sodium can be used when the patient is having difficulties with hypotension on dialysis or when it is difficult to reach the patients ultra-filtration target.
4) **[K^+]in dialysate: 1.5, 2.5 or 3.5 mmol/l.** The aim is for a pre-dialysis K^+ of 4.0 – 5.5. Suggest starting at a dialysate K^+ of 2.5mmol/L if the pre-dialysis K^+ is at target.
5) **Ultra-filtration :** refers to amount of net fluid removal required over the course of the dialysis treatment. Usual target is to achieve the patient's "target" or "dry" weight. This is the weight that the patient would be if they had no peripheral edema or excess ECF volume. The dry weight is determined by clinical assessment of the ECF volume of the patient. As

ultra-filtration removes fluid directly from the intra-vascular space, achieving enough ultra-filtration such that the patient reaches their target weight can be difficult if the patient is hypotensive or if they are significantly above their target weight (typically 3 or more kg above target). In such situations, it may be preferable to have the patient dialyzed more frequently (e.g. short daily haemodialysis) with the ultra-filtration demand spread over a greater number of treatments. Ultra-filtration orders can be written in terms of a) target weight or b) litres to be removed. The first option (target weight) is preferable to ordering number of litres to be removed, however, if the patient cannot be weighed, the second option becomes necessary. During any given dialysis session, ultrafiltration may be "ramped" such that a greater proportion of the total uf is removed earlier in the dialysis session (eg, remove 40% over 1st hour, 30% over 2nd, 20% over 3rd and 10% over 4th).

6) **BP support** usually important in ICU setting. Can involve ramping Na, ramping ultrafiltration, saline infusions, blood, albumin, pentaspan or inotropic support. Wrapping of legs with Tensor bandages to enhance interstitial to intravascular fluid shifts within the ECF compartment may be helpful.
7) **Heparin** standard anticoagulation.
    a) normal : 1000 unit bolus followed by 1000 units/hour; discontinue heparin 60 minutes prior to the end of dialysis if patient has an AV fistula or graft; in patients with central venous catheters, continue heparin until the end of the treatment
    b) tight: as above except, 500 unit bolus followed by 500 units/hour
    c) none (the nurse will flush the dialysis membrane periodically with normal saline to prevent clotting). Heparin orders will

depend on risk of bleeding. For patients with active bleeding or at high risk for bleed, then the heparin choice should be "none".

8) **Other** Can give meds with dialysis. Some antibiotics are prescribed at end of dialysis. RBC transfusions, if required, are usually given while on dialysis.

Vascular Access for Haemodialysis

Three types of vascular access are available for hemodialysis. The access coordinator (6353) can facilitate the investigations and management of vascular access issues.

Note:

- IVs and BP measurements should be avoided in the limb that has an AV graft or fistula or one in which a graft or fistula is being planned

1) **AV Fistula** A surgical anastamosis of patient's artery to vein ideally placed in the non-dominant forearm, with upper arm or leg sites also possible. Arterialization of the vein is usually adequate by 6-8 weeks. Patency can be confirmed by feeling a thrill and/or hearing a bruit over the fistulae site. This is the preferred type of vascular access for chronic hemodialysis.
2) **AV Graft** Connection of an artery to vein using a "Gortex" vascular graft, usually in the upper arm or thigh. It can be used earlier than a fistula after creation (within 1 week) but is more problematic in terms of thrombosis and infections. A graft is the preferred access for chronic hemodialysis when a fistula cannot be created or fails to mature.
3) **Central venous catheters**

1) **Temporary** catheters are placed by housestaff and fellows under staff supervision as needed. These are double lumen catheters placed in femoral or internal jugular vein. They are used when dialysis is urgently required. The line insertion/removal cart is located in the room 8009 cc (technical lab-back of dialysis unit). The cart must be signed out in the book attached to the cart. The cart is check and stocked at least once per week. Use the "Site Rite" (a portable ultrasound) to localize vessel. NO MORE THAN TWO ATTEMPTS SHOULD BE MADE BEFORE CONSULTING THE RENAL FELLOW OR THE STAFF NEPHROLOGIST. A formal sterile procedure with gown and mask and skin scrub with betadine is used. All lines are sutured securely in place. The exit site is covered with a 2X2 gauze with betadine ointment. This is covered with a 4X4 gauze and taped with a Tegaderm that has had a slit cut in it to accommodate the exit of the catheter.

   Citrate (4%) is instilled in each lumen (check volume of each lumen, it is printed on the side of the catheter) as a locking solution. If heparin is using as the locking solution, dose, the dose is 5000 units/lumen (i.e. .5cc of 1:10,000 diluted with saline to the volume of the internal lumen). A CXR is needed to rule out complications of insertion, such as pneumothorax, and to check that the tip of the tip of the IJ line is in the SVC or the right atrium.
2) **Permanent** Commonly referred to as an "Uldall Cook" or "UC line" or other long term catheter. The catheter is placed in the internal jugular (IJ), then runs through a subcutaneous tunnel

and exits the skin about 5 cm below the clavicle. Tunnelled catheters are inserted by interventional radiology under fluoroscopy. This is the preferred method for central venous catheter insertion. Can usually get it on day of request, by calling radiology at X5886 and faxing the requisition to X5380.

Note: Central venous lines are the least preferred long-term access for chronic haemodialysis. They are associated with thrombosis, infection, and inadequate dialysis.The advantage is that they can be used immediately.

Problems with Central Venous Dialysis Catheters

1) Line migration: Do NOT push the catheter back in. If there is sufficient catheter length remaining in the central vein, the dialysis can be done and plans made to replace the catheter before the next dialysis. If it is a temporary catheter and there is good flow through the venous port, the line can be changed over a guidewire. If there is no flow through the venous port, a new line insertion is required.

2) Cannot aspirate from the arterial port: If you can infuse without resistance, the arterial port is likely against the wall of the vein or the patient is ECF volume depleted- play the patient in slight Trendelenburg or reverse the lines.

- If you cannot infuse without resistance the arterial lumen is blocked. You can infuse TPA and wait 1 hour in an attempt to lyse the thrombus.

3) Cannot aspirate from the venous port: Check to see if line

kinked - if so should be changed and sutured to minimize kinking.

- If you can infuse without resistance, either the patient is volume contracted or there is a "ball valve" thrombus. Try positioning the patient in a supine position or in the lateral decubitus position (line side up), or TPA respectively.
- If it is a left sided line perhaps the tip is against the superior vena cava and a longer line could be necessary. Ensure there is no pain on infusion as in a very rare instances, the tip could have migrated through the wall of the vein.
- Otherwise, if the patient is not volume contracted, TPA fails and the line is not against a wall, the line should be changed.

4) Line started out fine but now BPS above 200 generate arterial insufficiency: The initial good function rules out kinks and thrombi and suggests mechanical problem (line sucking on vein wall) due to circulating volume contraction. Patients with low serum albumin can be circulating volume contracted yet still have +++ edema. Use tilt stretcher with patient head down and you will have to remove volume slowly. Support stockings will minimize problem. Be patient, the line sucking the vein wall produces spasm and aggravates the problem

5) Both ports aspirate well but BPS >200 are problematic: Is patient circulating volume contracted? If you cannot be sure, place head down on tilt stretcher and give 200-500 cc normal saline and evaluate impact. If JVP clearly elevated, do not give the saline, just place head down.

- If all efforts fail, check X-ray position of line to see if long line will be beneficial and have line changed.

6) Cannot aspirate from or infuse into either port: Ensure the clamps have not left the silastic compressed; check for kinking, clotting, locking solution protocol, coumadin protocol. Check CXR. Trial of TPA or new line as necessary

7) Suspected line sepsis (**see policy and procedure algorithm**)

- If a patient with a catheter develops signs & symptoms of infection, always consider CVC-associated bacteremia. However, CVC-associated bacteremia should be a diagnosis of exclusion after all other potential infectious foci have been considered.
- Look for redness/discharge at the exit site for evidence of exit site infection and for fullness or tenderness along the catheter tunnel for evidence of tunnel infection.
- Most common source of fever and sepsis in HD patients at SMH is due to staph species.
- Need blood culture (consider doing two or three blood cultures) and a C&S swab from the exit site
- Start empiric therapy with Ancef 2 gm IV last hour of dialysis and gentamycin (2 mg/kg load; 1mg/kg post dialysis for 3 weeks).
- Treatment is usually for 3 weeks and is adjusted at the next dialysis pending culture results and antibiotic sensitivities.
- Antibiotics are adjusted at the next dialysis based on the culture results and C&S. If the cultures are negative, the patient is reviewed before simply terminating the intended 3 weeks of therapy.
- Consider line removal at the onset of the infection only if the patient is very toxic. Otherwise, the decision for line removal is deferred until the next visit. Line change is considered if

symptoms of fever persist after 48 hours of appropriate antibiotic therapy, tunnel infections and recurrent infections. Otherwise, at St. Michael's Hospital lines are considered salvageable and routine replacement for a single episode of line sepsis is not advocated. This is a guideline and does not replace good clinical judgement.

- All lines get antibacterial ointment (polysporin or betadine if patient is polysporin sensitive) applied to the exit site at each dressing change.

Notes Regarding Patients Receiving Intensive Haemodialysis

Many St. Michael's Hospital dialysis patients are receiving higher than conventional doses of haemodialysis. Examples of intensive haemodialysis include:

- short daily in-centre (4 or 5 times per week for 2.5 to 3.5 hours)
- nocturnal in-centre (3 times per week for 7- 8 hours overnight)
- short daily home(5 or 6 times per week for 2.5 to 3.5 hours)
- nocturnal home (5 to 7 times per week for 6 - 8 hours overnight)

Patients receiving intensive haemodialysis may have non-standard dialysis bath compositions. For example, they may be on a higher than normal potassium concentration or have phosphate (as fleet phospha soda) added to the dialysate. These patients often can have a far more liberal diet and fluid intake. If an intensively dialyzed patient is admitted to hospital and converted to a conventional dialysis dose (4 hours 3 times per week), their entire dialysis prescription should be reassessed, and dietary restrictions should be started as appropriate. In general, it is best to keep a patient who normally performs an intensive form of haemodialysis on an intensive form (e.g. in-centre intermittent nocturnal haemodialysis) while they are admitted.

Some Hints for the Consult Team

When chronic dialysis patients are admitted to other services, the nephrology consult team will be consulted in order to manage dialysis related issues. In addition to ordering dialysis, the consult team should monitor for co-interventions ordered by other teams that may require major modifications in a dialysis patient.

1) **Medications** It is crucial to review the pre-admission medication list for all dialysis patients and ensure that these are continued or held (as appropriate) during the hospitalization. The patient's medication list may be found in his/her dialysis chart and should be reviewed at the outset of each hospitalization. At the time of discharge, it is important to identify dose adjustments to pre-existing medications, medications that have been discontinued permanently and medications that need to be restarted after being temporarily held. This information should be conveyed to the patient's primary nephrologist.

   For all patients with acute or chronic (including chronic dialysis patients) kidney disease, the medication list should be frequently reviewed o ensure that all medications that have been prescribed by the admitting service are not contraindicated in the setting of kidney disease. Furthermore, the consult service should verify if the medication dose and frequency is appropriate for the degree of kidney function. Note that some medications need to be given POST-dialysis and in some cases, post- dialysis supplemental doses are needed.

2) **Bowel preparation** Magnesium, citrate, aluminium and phosphate containing bowel medications should be avoided. Fleet enemas (primarily PO4), in particular, should always be avoided. If bowel

preparation is required, the preferred solution is CoLyte or PegLyte. Although large volumes are typically required, these solutions (when used appropriately) are not absorbed and are not contraindicated in dialysis patients.

3) **Maintenance IV solutions** The volume of delivered IV solutions should be monitored in dialysis patients. Standard maintenance orders (e.g. normal saline at 100cc/hour) could rapidly lead to volume overload in a patient with CKD.
4) **Dialysis dose and prescription** Patients who are acutely ill may require modification of their dialysis prescription. If oral intake is reduced, patients may require a higher dialysate potassium concentration, and may require supplementation of calcium or phosphate. Ultra-filtration requirements can be significantly altered during a hospital admission. Patients may become uremic on what was previously an adequate dialysis dose, and either more frequent treatment, longer treatments or both may be required. Ultra-filtration, solute removal, and biochemical parameters should be monitored longitudinally, with adjustments of the dialysis prescription made as required.

Renal Replacement Therapy for Acute Kidney Injury

Renal replacement therapy for acute kidney injury (AKI) is frequently required when conservative measures fail to prevent or control life-threatening complications of AKI (eg, congestive heart failure, hyperkalemia). In addition, severely ill patients with established AKI and no evidence of impending renal recovery are often started on renal replacement therapy. This criterion for renal replacement therapy initiation is more subjective and there is no

consensus on the optimal time for commencement of renal replacement therapy in AKI.

Patients with AKI who require renal replacement therapy may be managed with intermittent hemodialysis (IHD), continuous renal replacement therapy (CRRT) or sustained low efficiency dialysis (SLED). The same patient may receive one or more of these modalities at different times of their course in hospital depending on the evolving clinical circumstances. PLEASE REVIEW ALL ACUTE RENAL REPLACEMENT THERAPY PRESCRIPTIONS WITH THE RENAL FELLOW AND/OR STAFF ON A DAILY BASIS.

Intermittent Hemodialysis (IHD)

In intermittent hemodialysis (IHD), conventional dialysis machines and prescriptions (akin to those used in the chronic setting as above) are applied to the setting of AKI. IHD may be administered anywhere in the hospital. IHD is typically reserved for patients with AKI who are hemodynamically stable, including patients who received SLED or CRRT who have become hemodynamically stable. IHD is the most efficient form of dialysis and is the most effective way to manage life-threatening hyperkalemia (even if the patient is hemodynamically unstable) and intoxications (see below). The typical session duration is 3-4 hours at blood pump speeds of 300-400 mL/min. Anticoagulation is preferred but sessions may be feasibly administered with no heparin. Hemodialysis nurses administer IHD and sessions need to be arranged in coordination with the Hemodialysis Case Manager or the dialysis nurse on call.

Continuous Renal Replacement Therapy (CRRT)

Continuous renal replacement therapy (CRRT) provides 24-hour renal replacement therapy using relatively slow blood flow and ultrafiltration rates. Hemodynamically unstable patients are those who are most likely to benefit. CRRT may be administered as continuous veno-venous hemodialysis (CVVHD), continuous veno-venous hemofiltration (CVVH) and continuous veno-venous hemodiafiltration (CVVHDF). CRRT is only available in the MSICU and CVICU and is administered using dedicated Prismaflex™ machines. Critical care nurses are responsible for setup of the machines and administration of therapies. The Nephrology consult service is responsible for ordering, monitoring and adjusting the CRRT prescription. Pre-printed orders are available in the MSICU and CVICU to help guide CRRT prescription. One set of orders is employed for patients receiving heparin or no anticoagulation; another set is used for patients receiving regional citrate anticoagulation. **Completed orders must be reviewed with the Nephrology fellow and/or staff prior to submission to the ICU nurse.**

Clearance modes in CRRT

CVVHD employs dialysis exclusively as the mode of clearance; all solute removal is by diffusion. CVVH utilizes hemofiltration as the only mode of clearance. All solute removal is by convection. Pure CVVHD cannot be delivered on the Prismaflex as there is an obligate 200 mL/hr of hemofiltration that must be given for technical reasons.

Practically speaking, most patients will receive a combination of dialysis (diffusion) and hemofiltration (convection) in the form of continuous veno-venous hemodiafiltration (CVVHDF).

Indications for CRRT

- Patients who require acute hemodialysis and are hemodynamically unstable to the point where conventional haemodialysis is very high risk (this is a judgement call; note that in very unstable patients, even CRRT may not be tolerated)
- Patients with very large ultra-filtration needs, coupled with large IV infusion rates

Intensity of CRRT

The total effluent dose per hour should 20-25 mL/kg/hr.

Anticoagulation for CRRT

Anticoagulation is almost always required in CRRT although under some rare circumstances, CRRT may be attempted with no anticoagulation. Two basic options for anticoagulation exist:

Regional citrate anticoagulation

Regional citrate anticoagulation provides isolated anticoagulation in the extracorporeal circuit through the chelation of calcium by exogenous citrate which "paralyzes" the coagulation cascade. Systemic anticoagulation and hypocalcemia are avoided by the concurrent administration of exogenous calcium intravenously. All patients are eligible for regional citrate anticoagulation although this strategy is relatively contraindicated in patients with hepatic dysfunction due to the risk of citrate accumulation as a result of impaired liver metabolism. Regional citrate anticoagulation is especially indicated for patients who cannot have heparin (e.g. HIT) or systemic

anticoagulation in general (e.g. patients at high risk of bleeding such as those who have had recent surgery, active/recent bleeding or thrombocytopenia).

Practically speaking:

- Citrate chelates Ca^{+2} in the circuit; at ionized calcium of < 0.40 mmol/L, the coagulation pathway is inactivated.
- $CaCl_2$ is re-infused to the patient to maintain normal systemic ionized calcium
- Ionized calcium in both the circuit and the patient are monitored
- Circuit ionized calcium is adjusted by a sliding scale of citrate infusion rates
- Patient ionized calcium is adjusted by a sliding scale of $CaCl_2$ infusion rates
- To maximize citrate effectiveness and to minimize the amount of citrate used, a Ca^{+2} free dialysate is used (Prismocal™)
- Anticipate potential problems:
    - **metabolic alkalosis** may develop after about 2 day as citrate is a source of bicarbonate…manage with ultra-filtration (i.e. remove high bicarbonate) and replace this fluid with saline. (see pre-printed orders)
    - **citrate accumulation** may develop in patients with liver problems who are not able to metabolize the citrate load. This is recognized by an expansion of the citrate gap (i.e. total calcium-ionized calcium).

Heparin

Systemic unfractionated heparin may be administered to prevent clotting of the extracorporeal circuit. aPTT is targeted to 60-85 seconds using a protocol that is found in the pre-printed orders. This is identical to the "high PTT nomogram" that is used across the hospital for patients receiving unfractionated heparin.

Sustained low efficiency dialysis (SLED)

Sustained low efficiency dialysis (SLED) utilizes conventional dialysis equipment (as in IHD) applied over a more prolonged treatment time and with a lower blood flow (as in CRRT). As such, SLED has been described as a hybrid therapy that captures the benefits of CRRT (ie, greater hemodynamic tolerability) and IHD (ie, lower material costs, option for no anticoagulation). SLED may be administered in any critical care unit (MSICU, CVICU, TNICU or CCU) by a hemodialysis nurse. Patients with hemodynamic instability (similar to those being considered for CRRT) should receive primary consideration for SLED. Treatment duration is 8 hours at a blood flow of 200 mL/min and a dialysate flow of 350 mL/min. SLED may be administered with no anticoagulation. Given the intensive nature of the dialysis provided by SLED, patients may become hypophosphatemic after 1-2 SLED sessions; phosphate may be added to the dialysate in such individuals for subsequent sessions. All aspects of the SLED prescription are found in the pre-printed SLED orders which should be completed for each session.

Management of Intoxications

All poisonings should be managed with the supervision of renal fellow and staff Nephrologist. The management of intoxication requires a high dose of high efficiency dialysis. Slow low-efficiency techniques such as PD or CVVHD should not be used unless there is no other option (ex. intoxicated PD patient being managed at a peripheral hospital that does not offer dialysis awaiting transfer to SMH).

Poison Control Telephone Number: (416) 813-5900

Hemodialysis

- For solutes that have low MW, are not protein bound, and are water soluble
- Concurrent: renal failure, acid-base disturbance, electrolyte or volume abnormality correctable by dialysis
- Requires vascular access and anticoagulation

Hemoperfusion

- Blood passes through a cartridge with activated charcoal or other sorbents
- For toxins that are more lipid-soluble, higher MW
- May cause thrombocytopenia
- May be less destabilizing than HD if hypotensive
- Requires vascular access and anticoagulation

Examples of intoxications

Methanol

Industry solvent (e.g. windshield washer fluid, antifreeze)

- $T_{1/2}$ variable: 12-20 hrs, minimum lethal dose 50-100 ml
- Metabolism – oxidation to 1) formaldehyde and 2) formic acid
- Clinical manifestations
  - Early Stage (< 6 hrs): non-specific, mild or transient: inebriation, drowsiness
  - Delayed Stage (6-30 hrs): Vertigo/N/V abdo pain
  - Kussmaul breathing
  - Blurred vision (papilledema, disc hyperemia)→ blindness
  - Seizures, opisthotonus, coma → death
  - Lab findings: AGMA, osmolar gap, ↑ formate level, ↑ lactate level, ↑ amylase (pancreatitis)
  - Toxic levels: >10mmol/L (50 mg% or 500 mg/L)

- **ANY level with anion gap metabolic acidosis**

- 4 ml methanol has caused blindness - 15 ml of methanol can be lethal
- Metabolized by alcohol dehydrogenase - has lower affinity for methanol than ethanol.
- Metabolized into formic acid - causes the large anion gap metabolic acidosis.
- Prognosis dependant on amount of methanol metabolized and determined by the time between ingestion and treatment, the amount of ethanol on board, the degree of acidosis and the extent of the visual disturbance.
- Diagnosis is usually made by history and biochemical "footprints". An anion gap metabolic acidosis with an osmolar gap between measured and calculated osmolality is classic (calculated osmolality = Na x 2 + urea + glucose). The difference represents the mosmoles of methanol and can be used to guess the level until levels are available.

Management: Alcohol dehydrogenase inhibition and Hemodialysis

Alcohol dehydrogenase inhibition

- Ethanol is given as an antidote - orally or by IV. Aim for a blood level of 100 mg% (20-25 mmol/L). The alcohols are distributed across total body water.
  - Oral Ethanol
    - Loading dose of 40 gm ethanol. (Absolute or 95% ethanol has SG of 0.8 gm/mL.) This works out to 50 mL of absolute ethanol or 120 mL of 40% ethanol like scotch. The maintenance dose is 12

mL of absolute or 30 mL (1 oz) of whisky per hour with frequent measurements to ensure levels as above.

- IV Ethanol
    - Begin with IV bolus of 0.5 gm ethanol/ kg
    - **NOTE**: Must be diluted to a 15% solution or less to be non toxic. Mix 72 mL absolute ethanol in 500 mL D5W or NS to give a solution of 10 gm/100 mL i.e. 100 gm/L. A 70 kg man gets 350 mL of this solution or 35 gm. This is followed by maintenance of 10 gm (100 ml) per hour. Continue infusion even if dialysis is in progress to make up for metabolized ethanol.
- Fomepizole
    - For acute management of methanol or ethylene glycol intoxication at peripheral hospital until patient is stable for transport. This drug is very costly and is routinely available at SMH.

- **Hemodialysis**
    - Hemodialysis indicated for serum methanol levels > 10 mmol/L, or even at lower levels if anion gap metabolic acidosis is present.
    - Dialyze at Qb of 300 or more
    - Ethanol is added to the dialysate (500cc of 100% ethanol to 8L of the bicarbonate concentrate) to avoid blood ethanol from being dialyzed from the patient. Change dialyser q 6 hr
    - Continue to dialyze to methanol level < 5 mmol/L. By the time this result is back, actual level will be much lower. D/C dialysis and send final methanol level. Dialysis often needed for > 10 hours.

- PD is less effective but may be of some use in those who cannot be hemodialyzed. Add ethanol to the PD fluid.
- Follow the blood levels on a flow sheet

Ethylene Glycol

- Component of antifreeze and solvents. Dialysis indicated for level > 6 mmol/L or lower levels with anion gap acidosis
- $T_{1/2}$ is 3 hours
- Lethal dose ~ 100 mL.
- S/S - neurological– drunkenness to coma, tachypnea, pulmonary edema, flank pain and RF
- Classically, but not always, crystalluria (needle shaped or envelope shaped crystals)
- Management is same as methanol intoxication, i.e. ethanol and hemodialysis.

Theophylline

- Chronic intoxication – more severe clinical manifestations than acute and may have liver or renal involvement contributing to intoxication
- Acute - usually intentional overdose
- Toxic levels 450 umol/L in acute overdose or 220 umol/L in chronic overdose
- Small vol of distribution + low rate of clearance - effectively cleared by HD and charcoal hemoperfusion (HP) (hemoperfusion approx 2x as effective due to removal of protein-bound drug)
- Use two sites for venous catheters
- HD – use max blood flow, minimum 4 hours

- HP – use charcoal cartridge, saturates in about 2 hours and hence the cartridge must be changed q2h
- Serial HD-HP delays saturation of HP cartridge
- No guidelines re level to dialyze to, advisable to continue to < 100umol/L

Lithium

- Therapeutic range: 0.4-1.3 mEq/L
- Toxic manifestations may appear >1.5 mEq/L
- Clinical manifestations:
  Acute intoxication: N/V, neuromuscular irritability, coarse tremor, ataxia, slurred speech, confusion, fever, stupor, coma, CV collapse
  Chronic intoxication: polyuria & NDI, renal acidification defects, CIN, thyromegaly
- Lab manifestations: leukocytosis; ECG: flattened T's, AV blocks, QT prolongation

Management

- Well hemodialyzable
- Hemodialysis for 8-12 hours and monitor post plasma Li levels q4h for 36 hours
  - Indications:
    - Li level > 4.0 meq/L
    - Li level >2.5 meq/L if symptomatic or renal insufficiency
    - Goal: sustained level of 1 mmol/L 8 hrs post HD
- Dialyze 8-12 hours
- Monitor for post HD rebound as slow equilibration between extra and intracellular lithium. May require repeated HD treatments

Salicylates

- Aspirin, oil of wintergreen (topically)
- Minimum lethal dose 10 g ASA; levels useful 6 hrs post ingestion
- Acute ingestion: 1 tab/kg = severe (1 tab = 325 mg)
- Metabolism – ASA hydrolyzed to salicylic acid → glycinated to salicyluric acid in liver→ excreted via kidneys; urine pH > 7.0 enhances excretion
- Clinical manifestations
- Chronic ingesters : HA, tinnitus, ↓hearing, dizziness, weakness, N/V, ↑RR, confusion
- Acute/severe intoxications: above + fever, seizures, coma, ARDS
- Acid base disturbances:
- Respiratory alkalosis → resp alk + AG metabolic acidosis → metabolic acidosis

Management

- Systemic and urine alkalinzation urine: goal urine pH >7.5
- Hemodialysis Indications:
  - Salicylate level > 7 mmol/L
  - Seizures/coma
  - Severe metabolic acidosis, especially with renal failure
  - Non cardiogenic pulmonary edema
  - Especially if elderly, smoker, acute on chronic ingestion

Home Dialysis

Location: 8CCN Internal Extension: 3848

Hours: Monday to Friday 8am-430pm

Clinic: Tuesdays 1200pm-1600pm in Home Dialysis Unit

Post Clinic Rounds/Review: Thursdays 9:15-10:30 8CCS Conference Room

Academic Rounds: Thursdays 1-2pm 8CCS Conference – check schedule for topics

Focus: Training for Peritoneal and Hemodialysis at home with ongoing follow up post training.

Home Hemodialysis

While the majority of HD patients are on in-centre HD three times weekly, there is a subset of patients who are trained to do HD at home. For these patients, there is no universal HD prescription, as patients have more flexibility to individualize their treatment. Some common examples of home dialysis prescriptions include short daily HD (3 hrs, 5-6 days per week) and nocturnal HD (7-8 hours, 3-6 nights per week). Patients are generally seen in clinic at 2 month intervals, or sooner if necessary. For any home HD issue, it is important to consult with the multidisciplinary team in the Home Dialysis office on the 8th floor of the Cardinal Carter wing (416-864-5794 or extension 3848 or Case Manager extension 6977).

PERITONEAL DIALYSIS

The peritoneal membrane can be used to perform dialysis (PD). Dialysate is infused into the peritoneal cavity, and allowed to dwell for a period of time, during which toxins diffuse out of the blood into the dialysate. Ultrafiltration (UF) also occurs during this time, as fluid is drawn out of the circulation by the osmotic force of compounds such as dextrose in the dialysate. Once the dwell is over, the dialysate is drained from the peritoneum, and fresh dialysate is instilled.

The process of draining spent dialysate and reinstilling fresh solution is known as an "exchange". PD comes in a variety of forms, which are discussed below. For any peritoneal dialysis issue, it is important to consult with the multidisciplinary team in the Home Dialysis office on the 8th floor of the Cardinal Carter wing (416-864-5794).

Peritoneal Dialysis Subtypes:

CAPD (Continuous Ambulatory Peritoneal Dialysis)

CAPD involves manual exchanges performed either by the patient and/or caregiver at home. Patients performing CAPD typically perform four 2 L exchanges per day, usually upon awakening, at lunch, at dinner and prior to bed. Exchanges are done using a "twin-bag" system, consisting of an empty drain bag and a full dialysate bag connected by a Y connector. A CAPD exchange first involves connecting the Y connector of the twin-bag to the patient's PD catheter. Spent dialysate is then drained into the drain bag. Once the peritoneum is empty, fresh dialysate is instilled into the peritoneum from the dialysate bag. This process typically takes from 20 to 40 minutes.

When prescribing CAPD, order volume of exchange (usually 2L), frequency of exchanges (usually 4x/day), additives (usually none), target weight specifying whether or not this includes the exchange volume (eg. dry weight 75 kg empty).

Example: CAPD 2 L fill volumes qid, target weight 68 kg (full with 2 L).

Note- for PD patients who are in the emergency department for prolonged periods of time or any other hospital location where automated peritoneal

dialysis (APD) may not be possible or readilty available to set up routine CAPD exchanges may be used in place of the patients' usual APD prescription until such time that the APD ''cycler'' system may be set up. Exchanges would typically be ordered every three to four hours.

APD (Automated Peritoneal Dialysis)

An automated machine called a "cycler" can be used to instill and drain dialysate from the peritoneal cavity. Typically such a machine is used as night, with the cycler performing the dialysis exchanges while the patient sleeps. However, in admitted patients particularly those in a critical care setting who are bed-bound it may be used during the daytime as well. Normally, a larger number of exchanges can be ordered than would be practical during the day (eg. 4-5 exchanges over 9 hours). In some cases, the patient can tolerate a larger volume of dialysate at night as well (eg. 2.5L) because of lower intra-abdominal pressure when supine. While CAPD bags are usually 2 or 2.5L, APD bags are usually 5L. APD can be performed in one of three ways depending on the desired dialysis dose, discussed below:

(1) NIPD (Nightly Intermittent Peritoneal Dialysis)

In this form of dialysis the cycler is used to perform exchanges during the night. In the morning, as the dialysis program is ending, the cycler drains the patient, who then disconnects from the machine and remains empty through the day. The cycle begins again the next evening, when the patient hooks back up to the cycler. To order NIPD, specify the number and volume of exchanges, the total number of hours of the cycler program, and the dextrose concentration of the dialysate or the patient's target weight.

Example 1: NIPD, 5 exchanges over 9 hrs, 2L fill volume, no last fill, target weight 65 kg

Example 2: NIPD, 5 exchanges over 9 hrs, 2L fill volume, no last fill, 2.5% Dianeal for all exchanges

(2) CCPD (Continuous Cyclic Peritoneal Dialysis)

Continuous cyclic peritoneal dialysis is similar to NIPD, but rather than have the patient empty during the day, the patient carries dialysate for part or all of the day. This is performed using the "last fill" option of the cycler. In NIPD, at the end of the cycler program the cycler drains the patient until they are empty, at which point the patient disconnects from the machine. In CCPD, the patient is drained, and then is refilled from either the same dialysate solution that was used overnight or a separate dialysate bag, and the patient completes the cycle program with fluid in their peritoneal cavity. This fluid is either kept in for the whole day and drained at the start of the next night cycle, or is drained at some point during the day. The last fill usually comes from a standard CAPD-type dialysate bag. Icodextrin solution is a good choice if the last fill is to dwell until the late afternoon or evening in order to prevent fluid absorption and promote UF. Order CCPD as you would NIPD, but you must also specify the composition, volume and duration of the last fill. Note that CCPD patients will have a target weight ''full'' and this must take into account the weight/volume of the day exchange. NIPD patients will have a target weight that is ''dry'' owing to no residual fluid in the peritoneal cavity during the day. .

Example: CCPD, 5 exchanges over 9 hrs, 2 L fill volume, 1.5%/2.5% Dianeal. Last fill 2L Icodextrin. (In this example, since the total night

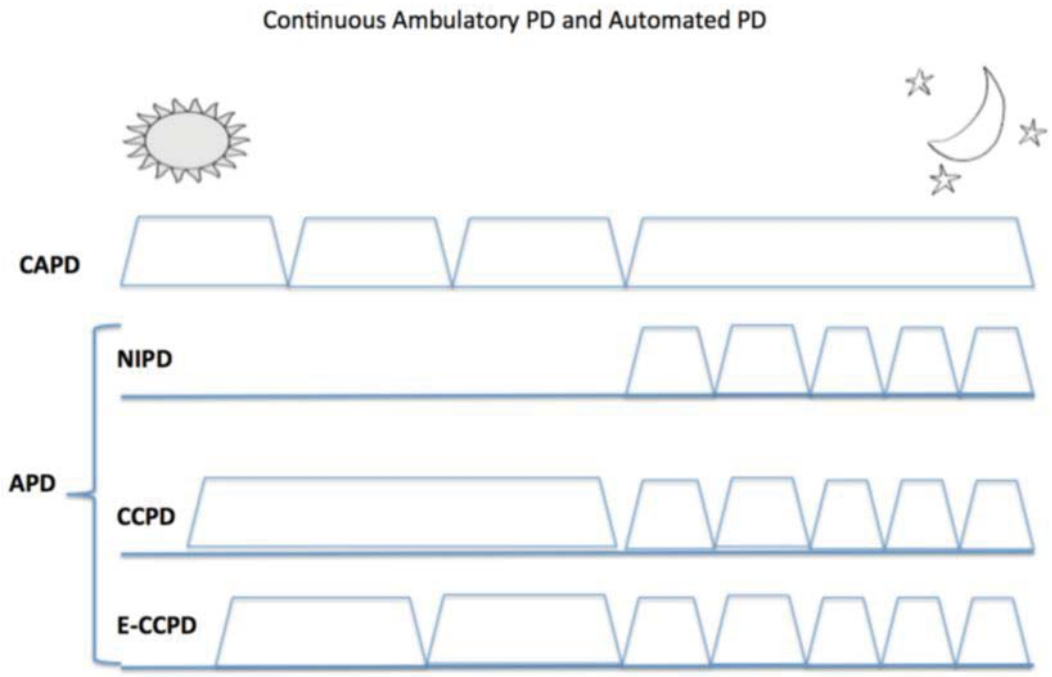
volume is 10L, the 1.5%/2.5% means that the patient/nurse will use one 5L bag of 1.5% solution and one 5L bag of 2.5% solution).

(3) Enhanced CCPD

In patients who are not able to achieve adequate dialysis with CCPD, additional twin-bag exchange(s) can be added to the CCPD (night cycler + last fill) prescription. A CAPD twin bag is used for the daytime exchange. Order enhanced CCPD as you would standard CCPD, but you must also specify the composition, volume and timing of the additional exchanges, as well as any additives as required.

Example: Enhanced CCPD, 5 exchanges over 9 hrs, 2 L fill volume, 1.5%. Last fill 2L of Icodextrin. Twin bag exchange 2L of 2.5% at 4 PM

For patients admitted to hospital, enhanced CCPD can also be delivered by continuous use of the cycler. This may meet the patient's medical requirements, as well as being more convenient for the nursing staff.



Peritoneal Dialysis Solution Types and Strengths

Standard dialysate (Dianeal™) comes in four dextrose concentrations, 0.5%, 1.5%, 2.5% and 4.25%. The higher the percentage of dextrose, the more likely UF will be achieved. As a rough guide, a 2 L 4-hour dwell with 1.5% solution should result in 0-100 cc of UF, while a 2.5% solution should result in 150-250 cc UF and a 4.25% solution should produce > 400 cc UF. A 0.5% bag is usually only used when the patient is hypotensive and volume contracted, as it typically results in a net negative UF (i.e. less fluid is drained out than instilled, with a net infusion of solution into the intravascular space). A 4.25% solution should only be considered in emergent settings (i.e. severe pulmonary edema) and is generally not recommended as part of a chronic peritoneal dialysis prescription. A more precise estimate of expected UF for a given dextrose concentration can be achieved by consulting the patient's log book from home.

On occasion, it is necessary to specify the concentration of dextrose in the dialysate, in order to give more precise instructions to the nursing staff. When a target weight is ordered and no specification is given regarding dialysate dextrose concentration, the nursing staff will consult a pre-made table that will provide them with guidance on how to select the dextrose concentration.

There are three specialized PD solutions available:

(1) Extraneal™ (icodextrin) – uses a non-dextrose molecule to provide the osmotic force for UF. In contrast to dextrose-based solutions, Icodextrin is not readily absorbed into the bloodstream, so there is no dissipation of the osmotic gradient for UF. This solution is therefore ideal for a long dwell in order to prevent net absorption of fluid and to promote UF. Icodextrin should typically only be used for one long (6 to 16 hour) exchange daily (overnight exchange in CAPD patients/ day exchange in APD patients).

(2) Nutrineal™ - an amino acid-based solution. This solution can be used to supplement amino acids in malnourished patients. The amount of supplementation is relatively small, and use of this solution does not preclude the need to identify and treat causes of malnutrition. Nutrineal should not be used with short dwell times (eg. night cycler) as the nutritional benefit will be minimized. Since both Extraneal and Nutrineal are not dextrose-based, they have the advantage of not leading to absorption large quantities of dextrose as does standard dialysate. Nutrineal should only be used for one exchange daily as the amino acid load can cause metabolic acidosis. Nutrineal also does not produce a large volume of UF, and should not be used in patients requiring aggressive ultrafiltration.

(3) Physioneal™ – a neutral pH, bicarbonate-buffered solution (all other bags use lactate as a buffer). Physioneal may be tried in patients with persistent abdominal pain during/after infusion as this pain may be due to the low pH of standard solutions. Others have suggested using Physioneal for long term preservation of the peritoneal membrane, although supportive data is lacking. When used, Physioneal should replace all Dianeal exchanges.

It should be noted that all three specialty PD solutions are significantly more expensive than standard dialysate, and should therefore only be used when clinically indicated.

Inpatient PD Management

The general day-to-day management of the dialysis is done in conjunction with the Home Dialyis Case Manager.

Ward PD: is managed by 8CCS Nursing Staff.

****For Consult/Off service PD: Home Dialysis Case Manager and nursing staff are responsible for setting up and administering the peritoneal dialysis Monday to Friday 8am-4pm for the Consult/Off service patients. For weeknights and weekends and holiday hours it is the 8CCS Unit Leader.

All dialysis orders should be completed by 1pm.

PD PERITONITIS

PD peritonitis is PD fluid that has become infected and not related to any secondary cause of peritonitis (i.e. bowel perforation, appendicitis etc):

PD peritonitis requires two of the following three criteria to be fulfilled:

1. Signs/Symptoms of peritoneal inflammation
2. Cloudy bags (or WBC count > 100 with **>50% neutrophils** (PMN's)
3. Positive dialysate culture or Gram stain

Initial Assessment

1) Clinical examination with particular attention to assessment of:
    - abdomen for symptoms and signs of peritoneal inflammation (eg. rebound)
    - peritoneal catheter exit site; send swab for C&S if drainage or pus present milk along tunnel of PD catheter if needed
        - rule out presence of incarcerated hernia
        - history- determine root causes – assess for breeches in sterile technique, assess if recent contamination of PD fluid, assess recent bowel habits.
2) Order first dialysate bag to be sent for Gram stain, C&S and cell count with differential. If patient is dry or recently completed the cycler, try to allow a dwell of at least 2 hours (can be as long as 4-6 hours) in order to get a meaningful sample. Bloodwork on admission - CBC and differential, electrolytes, creatinine, urea, calcium, phosphate, protein, albumin. Note PD fluid that has been left in the peritoneum for an extended period of time may have an elevated cell count but this will be largely monocytes and is not indicative of peritonitis. Similarly cell counts from shorter dwells may be falsely low and may required a timed 2-hour dwell. In such cases rely

on the percent neutrophil cell count criteria to initiate empiric antibiotics as indicated below.

3) Order antibiotics (see below and pre printed order set for details)
4) Order dialysis prescription, including target weight. Antibiotic usually given IP once daily in 6 hour dwell
   - CAPD prescription usually does not need modification
   - Cycler patients should have antibiotics added to the longest dwell. For a cycler patient who normally does only NIPD, you can add a 6-hour day dwell (daytime exchange) on top of the usual nocturnal prescription. THE LAST FILL OPTION ON THE CYCLER CANNOT BE USED TO ADMINSTER ANTIBIOTICS IT REQUIRES A SEPARATE TWIN BAG EXCHANGE. Remember that the 6-hour antibiotic dwell is a minimum and can be in place longer
   - Patients may require higher % dialysate bags as peritoneal inflammation may lead to more rapid glucose absorption and therefore less UF
5) Order additional intraperitoneal additives:
   - Heparin 1000 u/L until effluent clears, then 500 U/L prn if fibrin still present
   - KCl, insulin as required
6) Order frequency for effluent sampling for inpatients (cell count daily until <100, and neutrophils < 50% and daily culture until total of 3 "no growths" and subsequently after the conclusion of antibiotic therapy.
7) For patients who are receiving vancomycin, check vancomycin levels at 48-72 hours post-initial dose.
8) Hold phosphate binders or calcium supplements if peritonitis is severe (due to constipation). Order appropriate diet and all other medications.
9) Patients on peritoneal dialysis who present with peritonitis are managed as outpatients and CCAC usually assists in the delivery and administration of

IP antibiotics unless severity indicates hospital admission. Admission may be required for patients:

1. With severe pain
2. Who are frail or may lack supports
3. Intractable nausea and vomiting
4. Where concern exists regarding outpatient delivery and administration of intraperitoneal antibiotics..
5. Where some degree of doubt exists over diagnosis (i.e. concern regarding other source of abdominal pain)

*** If no decrease in cell counts by day 5 or if count fell initially and then increased, repeat culture and consider:

(1) Inappropriate antibiotics for organism
(2) Associated exit site/tunnel infection
(3) Secondary peritonitis (eg. ischemic bowel, cholecystitis, diverticulitis, appendicitis, pancreatitis). Management of non-resolving peritonitis after 5 days of appropriate antibiotics is catheter removal.

Peritonitis treatment guidelines

Initial therapy:

Urine output	No allergies	Beta lactam allergy
<100mL/24h	Cefazolin and Tobramycin	Vancomycin and Tobramycin

>100mL/24h	Cefazolin and Ceftazidime	Vancomycin and Tobramycin

No allergies:

Patients with < 100 mL /24h urine:

If patient <50 kg: Cefazolin 1g in ONE exchange/day
Tobramycin 40mg in ONE exchange/day
Ideal dwell time of 6 hours (at least 3-4 hours).

If patient >50kg: Cefazolin 1.5g in ONE exchange/day
Tobramycin 60mg in ONE exchange/day
Ideal dwell time of 6 hours (at least 3-4 hours)

Patients with > 100 mL/ 24h urine:

If patient <50kg: Cefazolin 1g in ONE exchange/day
Ceftazidime 1 g in ONE exchange/day
Ideal dwell time of 6 hours (at least 3-4 hours)

If patient >50kg Cefazolin 1.5g in ONE exchange/day
Ceftazidime 1.5g in ONE exchange/day
Ideal dwell time of 6 hours (at least 3-4 hours)

Beta lactam allergy (regardless of urine output):

Replace Cefazolin with Vancomycin 30 mg/kg (round up to nearest 500 mg to a maximum of 2 g) in ONE exchange q3-5 days. Monitor Vanco levels q3 days, and repeat dose when level <15 ug/mL. Follow dosing guidelines for Tobramycin above.

If presentation of peritonitis is within 4 weeks of previous episode, ensure antibiotic coverage addresses previous organisms antibiotic susceptibility.

Depending on C&S:

Treatment should be based on microbiological susceptibility test results. Commonly useful regimens are listed below but always check sensitivity results.

Enterococci:

Ampicillin 125 mg/L in EACH exchange X 21 days. (This may require conversion to CAPD for APD for some patients) If lab reports high level Gentamicin sensitivity and urine output <100mL/24h, consider adding Gentamicin 2 mg/kg IV q48h for severe cases. Check Gentamicin trough prior to 3rd dose (should be < 1 ug/mL). Patients on NIPD or CCPD should be switched for CAPD for the duration of Ampicillin therapy. Ampicillin and Gentamicin cannot be mixed in the same bag due to chemical imcompatibility.

If resistant to Ampicillin, use Vancomycin 30 mg/kg (round up to nearest 500mg to maximum of 2 g) in ONE exchange q3-5 days. Monitor Vanco levels q3 days, and repeat dose when level <15 ug/mL. Duration of antibiotic coverage would be 3 weeks.

Staph aureus:

	No allergies	Beta lactam allergy
Methicillin sensitive Staph aureus	Cefazolin	Vancomycin
Methicillin resistant Staph aureus	Vancomycin	Vancomycin

Methicillin-sensitive S. aureus: Cefazolin (according to previous dosing regimen) x 21 days. For severe peritonitis, consider adding Rifampin 300 mg po bid x 1 week. If there is an associated S. aureus exit site or tunnel infection, PD catheter should be removed.

MRSA: replace Cefazolin with Vancomycin 30mg/kg (round up to nearest 500 mg to maximum of 2 g) in ONE exchange q3-5 days. Monitor Vanco levels q3 days, and repeat dose when level <15 ug/mL.

Coagulase-negative staph:

Treat with Cefazolin (according to previous dosing regimen) x 14 days. If methicillin-resistant, replace Cefazolin with Vancomycin 30mg/kg (round up to nearest 500mg to maximum of 2 g) in ONE exchange q3-5 days. Monitor Vanco levels q3 days, and repeat dose when level <15 ug/mL.

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Single gram negative:

Ceftazidime 1g (1.5g if >50kg) in ONE exchange/day x 21 days. If patient allergic to beta lactams, options include Tobramycin 40mg (60 mg if >50kg) in ONE exchange/day x 21 days or Cipro 500 mg po BID x 21 days (based on organism sensitivity).

Multiple gram negatives +/- anaerobes:

Ampicillin and Ceftazidime (according to previous dosing regimen), and add metronidazole 500 mg po BID x 21 days. Rule out perforated viscus (i.e. may require imaging via CT)

Pseudomonas:

Ceftazidime 1g (1.5g if >50kg) in ONE exchange/day x 28 days, and add a second antipseudomonal antibiotic: eg. Cipro 500 mg po BID (if sensitive). If there is an associated Pseudomonas exit site or tunnel infection, PD catheter should be removed, and patient should be treated with IV antibiotics for 2 weeks after catheter removal.

Nystatin therapy 500,000 units po qid (swallow not swish) is given for all PD patients receiving a course of antibiotics. Continue for 1 week post the cessation of the antibiotic course)

Definitions

Refractory peritonitis: failure of the effluent to clear after 5 days of appropriate antibiotics

Relapsing peritonitis: an episode that occurs within 4 weeks of completion of therapy of a prior episode with the same organism or a sterile episode

Recurrent peritonitis: an episode that occurs within 4 weeks of completion of therapy of a prior episode but with a different organism

Repeat peritonitis: an episode that occurs more than 4 weeks after completion of therapy of a prior episode with the same organism

Catheter-related peritonitis: Peritonitis in conjunction with an exit-site or tunnel infection with the same organism

Indications for PD catheter removal
FUNGAL peritonitis-remove immediately this is an emergency even it the patient appears clinically well
Refractory peritonitis
Relapsing peritonitis
Refractory exit site/tunnel infection
Pseudomonas or S. aureus catheter-related peritonitis

Consider catheter removal if not responding to therapy
Mycobacterial peritonitis
Multiple enteric organisms

*NOTE IF CATHETER REMOVAL IS REQUIRED THE SERVICE WHO FIRST INSERTED THE CATHETER I.E. UROLOGY / INTERVENTIONAL RADIOLOGY IS RESPONSIBLE FOR ARRANGEMENT OF PD CATHETER REMOVAL. THE METHOD OF INSERTION SHOULD BE

CAPTURED IN SORIAN IMAGING AND/OR PROCEDURE NOTES . IF UNCLEAR CONTACT MINA KASHANI PD ACCESS COORDINATOR AT EXTENSION 2387.

Reference: ISPD: PD-related Infections Recommendations: 2005 Update (www.ispd.org)

Antibiotic prophylaxis for pd patients

PD catheter insertion and or manipulation of PD catheter via interventional radiology: Ancef 1 g IV 1 hour pre-procedure (or Vanco 1 g IV if beta-lactam allergy)

Dental procedures: Amoxil 2 g po 1 hour pre-procedure (or Clindamycin 600 mg po if beta-lactam allergy)

Colonoscopy:

If no allergies:

Ampicillin 2 g IV 1 hour pre-procedure

Ceftazidime 1.5 g IV 1 hour pre-procedure (1 g if < 50 kg)

Flagyl 500 mg po 1 hour pre-procedure and 500 mg 12 hours post

If beta-lactam allergy:

Vancomycin 1 g IV 1 hour pre-procedure

Tobramycin 1 mg/kg IV 1 hour pre-procedure

Flagyl 500 mg po 1 hour pre-procedure and 500 mg 12 hours post

Pd access program at st. Michael's

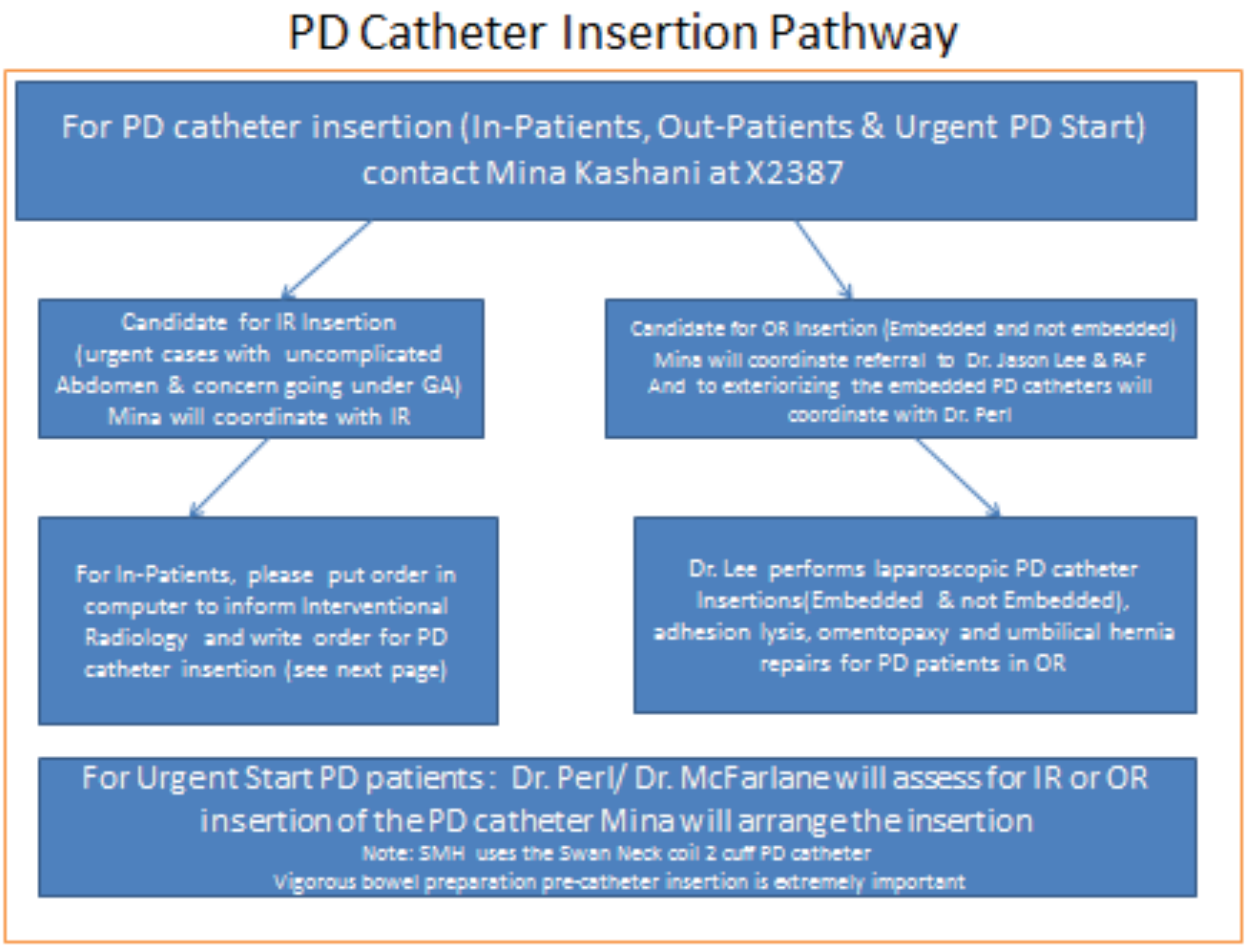
Mina Kashani PD access coordinator Ext. 2387

Dr. Jason Y. Lee PD access surgeon Division of Urology Ext. 3735

Interventional Radiology (IR) Ext. 6596

Dr. Jeff Perl Ext. 6016 (PD catheter exteriorization for embedded PD catheters))

PD catheters are inserted in one of two methods at St. Michael's Hospital via interventional radiology under fluoroscopy, and in the OR by Dr. Jason Lee using advanced laparoscopy. Each method has its advantages and disadvantages and for all PD access insertions consult the PD access coordinator Mina Kashani to determine the most appropriate method of insertion. The method is usually chosen using guiding principles as indicated in the pathway below



1) **Pre-Insertion** All patients going for PD catheter insertion should be given prophylactic antibiotics prior to insertion
2) Hold anticoagulants and antiplatelet therapies 1 week prior to catheter insertion (can individualize decision re. ASA/Plavix based on cardiac risk).
3) Hold calcium and iron for 2 days pre-insertion as they may predispose to constipation
4) Polythylene glycol with electrolyte (Klean-Perp) 250 cc po OD x 4 days prior to catheter insertion (can increase dose if necessary)

Prior to PD catheter insertion, please inform home dialysis unit. At St. Michael's Hospital, PD catheters may be inserted by interventional radiology (IR), or by

urology in the OR (usually open surgical approach, with laparoscopy reserved for complex cases).

Short Term Management

1. Sterile PD dressing to cover exit site and catheter until site heals (about 2 weeks)
2. Flushes should be done for any patient with a new catheter. This is done to assess the catheter function and to remove fibrin and blood from the peritoneal cavity. Order 500cc volume "in and out" until the effluent clears.

Long Term Management

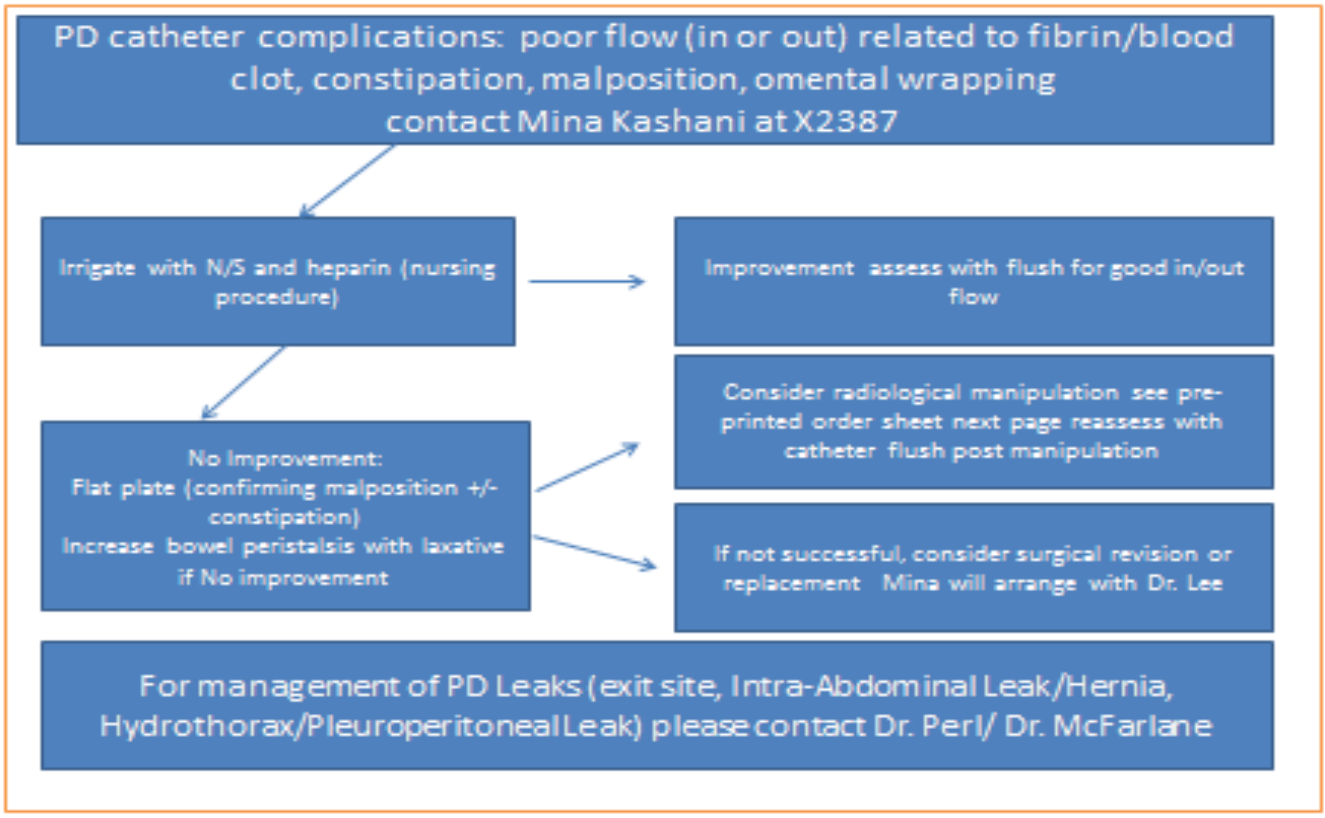
Standard nursing protocols for catheter exit care are used once the initial dressing is removed. Catheter care is every second day routinely with antibacterial soap and water followed by 2% chlorhexidine and a dry dressing. Twice weekly is the minimum frequency; exit site care should be increased for drainage or infected sites. Tobramycin ointment should be applied routinely by all PD patients with each dressing change.

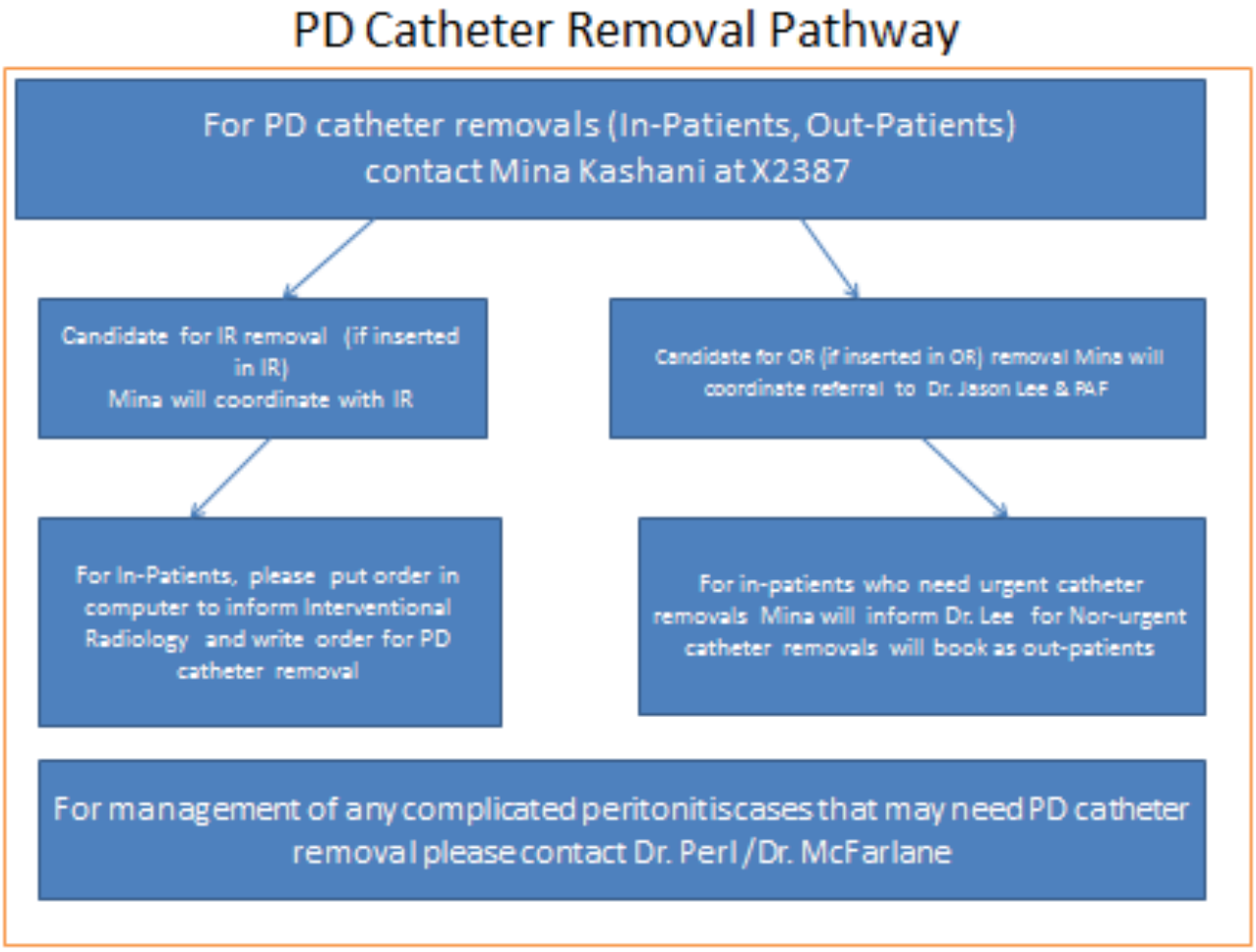
PD Catheter Dysfunction

If there is poor catheter flow, determine whether the difficulty is with outflow alone or both inflow and outflow. The most common cause of slow outflow is constipation.

- If there are problems with both inflow and outflow, consider mechanical obstruction of the catheter by fibrin/clot. Have the nurse irrigate with heparin and saline.
- Order abdominal X-ray to assess catheter position and presence of constipation. The PD catheter tip should be seen in the pelvis.
- If the catheter is in good position and there is evidence of constipation, increase bowel regimen and reassess in 2-3 days
- If the catheter tip has migrated out of the pelvis, refer patient for radiologic catheter manipulation
- If the catheter is in good position, there is no evidence of constipation and there is no improvement after catheter irrigation with heparin, the patient may have catheter dysfunction due to omentum wrapping around the catheter or adhesions (neither of which are visible on standard imaging techniques). Refer patient for radiologic manipulation (see preprinted orders after this section for PD catheter manipulation). If catheter dysfunction is recurrent, consider referral to Dr. Jason Lee for Laparoscopic PD catheter Revision +/- omentopexy/adhesiolysis.

Pathway for PD Access Complications





Intraperitoneal (IP) medications

Heparin Indicated if fibrin is present in bags or for slow drainage. For CAPD, may be used in all bags or overnight bag only in relation to presence of fibrin.

Dose (Non-peritonitis): 500 units/litre

Dose (Peritonitis): 1000 units/litre until effluent clears

Potassium Chloride (FOR APD ONLY)

Intraperitoneal KCl is not usually added, but may be considered if alternatives such as increased dietary intake or oral potassium

supplementation are not possible. It may be used for inpatients but is generally avoided in the outpatient setting.
Usual dose = 2 - 4 mEq/L. This dose will limit diffusive removal of K but will not supplement K to the patient. Max dose 10 mEq/L

PD Catheter Contamination:

Occasionally after hours a PD patient will present to emergency having had a breech in technique which we refer to as a contamination. If the contamination has led to PD fluid visible on the outside of the catheter during an attempted exchange this is referred to as a 'wet contamination''

Wet contamination happens when the fluid filled tubing system is accidentally opened or unclamped. If this happens it may lead to a subsequent peritonitis.

Examples of when wet contamination may happen:

- There is a disconnection between the transfer set and the catheter at the titanium
- There is a small hole in the transfer set or the catheter
- Any time the **twist clamp on the transfer set is not closed** and fluid escapes due to poor technique

Procedure:

1. Examine the PD catheter for any damage cracks or wholes and the PD catheter transfer set
2. Have the PD or Ward Nurses Change the PD catheter transfer set

3. Arrange for a prophylactic dose of IP antibiotics with either cefazolin or vancomycin.
4. Inform the home dialysis nurse on call that this has occurred as the patient/caregiver may require technique retraining.

RENAL TRANSPLANTATION

A. Pre-op procedures

Living donor transplant (LD)

There are many variations on the living donor theme:

1. Biologically related donors (siblings, parents, children)
2. Emotionally-related donors (spouse, friend)
3. Non-emotional directed donation
4. Living Donor Paired Exchange (chains)

Living donor admitted to Urology service day of surgery; you are not responsible for the donor. Recipient admitted to Nephrology service day prior to surgery; you are responsible pre-op and post-op.

1) The recipients' chart will be available on the ward. In addition all pertinent letters will be found in Soraian. **There will be a recent note from the transplant physician outlining the plan for this recipient, including potential for participation in clinical research**
2) Brief history of any recent hospitalization, surgery, illness or blood transfusions that would preclude an elective procedure (eg. recent MI)
3) Focused physical exam
4) If signs or symptoms of infection (fever, leukocytosis, etc) are present, consider delaying the surgery
5) If patient is on dialysis, they are usually dialyzed the day prior to surgery. Assess the need for an additional run of dialysis:

- volume overload (clinical exam, CXR)
- hyperkalemia (K > 5.0)
- If patient is on NPD, ensure they get their usual dialysis overnight

6) ORDERS: All transplant order sets are on CPOE including transplant orders for pre-op, post-op, and medications (more on these later).
7) Ensure CXR and ECG are reviewed the evening of admission.
8) Consider beta-blockers for patients with medium and high cardiac risk
9) TYPE 1 Diabetics (Some Type 2) will need an insulin drip started in the morning
10) Can give required meds in am of surgery

Deceased donor transplant (DD)

There are variations on the deceased donor theme: HOW THE DONOR DIES

1) DEATH BY NEUROLOGIC CRITERIA (NDD or Brain death)
2) DEATH BY CARDIO-CIRCULATORY CRITERIA (Donation after cardiac death(DCD))

For each of these 2, deceased donors can be subclassified by QUALITY OF KIDNEY:

A) STANDARD CRITERIA (SCD-Donors less than age 60, or healthy donors , <age 50
B) EXTENDED CRITERIA (ECD-Donors 60 yrs and older, or age 50-59 with 2/3 of the following: hypertension, spontaneous intracranial bleed, Scr>132 umol/l)

Exceptional distribution:

By health Canada regulations, all organ donors are deemed "safe" or "unsafe" for transplantation. The reasons for being unsafe are multitude and by example can vary from the donor having once resided in the UK (risk of mad cow disease), to a donor being a current intravenous drug user. Trillium Gift of Life staff obtains the medical/social history from next of kin. The attending staff will decide on donor suitability. "Unsafe" donors may still be used, but are deemed by Health Canada as EXCEPTIONAL DISTRIBUTION. The use of such donors requires additional consent by the potential recipient. The actual risks are exceedingly low, as all donors are screened for infectious disease by serology and in the case of "higher risk donors", additional PCR Nucleic Acid Test (NAT) tests for HIV, Hep B, Hep C are done.

Trillium Gift Of Life (TGOL) calls attending ward staff and lets him/her know that a kidney has become available for transplant Potential recipients are identified based on points system and a negative virtual cross match (See Appendix A) .

Recipients are called in by the following people:

A. Weekdays 8am-4pm: Transplant office Coordinator
B. Night time 4 pm-8 am : 8CC charge nurse
C. Weekend days : Renal Fellow or attending staff

Urology resident is to be called early on in the process by the above designates, as they need to see the recipient, obtain surgical consent and book O.R.

DONOR INFORMATION IS GIVEN TO ATTENDING (phone, PDF) and IS CONFIDENTIAL AND SHOULD NOT BE RECORDED IN RECIPIENT CHART

- age of donor

- NDD or DCD, ECD or SCD
- National Highly Sensitized Patient Registry (HSP), donors can come from anywhere in Canada, for recipients with cPRA of 95% or greater
- EXCEPTIONAL DISTRIBUTION or not (see above)
- nature of injury to donor
- amount of time on pressors
- baseline and most recent creatinine and GFR of donor
- underlying co morbidities (diabetes, hypertension, etc)
- anatomy of kidney (# of arteries and veins)
- time at which kidney was or expected to be procured
- blood type of donor
- serology of donor (CMV, EBV, HepB, HepC, HIV, HTLV)

For fellows; when you call in recipients:

- When speaking to recipient:
  - introduce yourself and reason for calling
  - ensure they are ready for transplant (not "on hold")
  - ask brief Hx for recent hospitalization, surgery, recent or ongoing illness, or recent blood products, and time of most recent dialysis
  - instruct to hold all anticoagulants, stay NPO, and come directly to 8CC nursing station
  - if Recipient's cPRA is >80%, consider calling in a back-up (always do for recipients with donors for the National Highly Sensitized Patient Registry (HSP)
  - If donor is exceptional distribution, will need to let recipient know and consent.

Housestaff/Fellows: Obtain recipient chart from Soarian/Sovera:

1. Get patient's MRN from recipient list on ward and logon to Soarian
2. In top right hand corner drop-down menu #3 choose "Sovera-Link"
3. In medical records, choose service "PRT" and click "view MRN"
4. In tabs click on "EXTERNAL" to get chart, scroll through scanned documents as you need (letters, lab, cardiac tests, other imaging)
5. Transplant physician, surgeon and anaesthesia letters on Soarian

- When recipient arrives perform focused history and physical exam, obtain blood work (including a STAT cross-match), CXR, ECG.
- If signs or symptoms of infection (fever, leukocytosis, etc) are present, consider cancelling surgery and calling in another recipient
- Assess the need for urgent hemodialysis:
    - volume overload (clinical exam, CXR)
    - hyperkalemia (K > 5.0)

Cross-match: (HLA lab : 416-340-4995)

a. All recipients will have a flow cross-match against potential donor
b. In the following cases the results of a STAT cross-match (await results and must be negative BEFORE beginning surgery):
    1. recent blood products
    2. cPRA > 80%
c. All cross match results will be called in to the attending staff physician. Stat x-match results in approximately 5 hours

KEY TEACHING POINTS REGARDING CALCULATED PANEL REACTIVE ANTIBODY (cPRA);

1) **cPRA [range 0-100%]calculated based upon degree of HLA class I and class II sensitization and Canadian organ donor pool**
2) **(1-%cPRA) = likelihood of finding a donor to which that recipient does not have any antibodies against (negative virtual cross-match or acceptable mismatch)**
3) **IN THE MODERN ERA, IN THE ABSENCE OF DONOR SPECIFIC ANTIBODY (DSA), THE % cPRA HAS NO CORRELATION WITH RISK OF REJECTION**

ORDERS

Use the ready-made transplant orders for pre-op, post-op, and medications (more on these later)

a. Consider beta-blockers for medium-high cardiac risk
b. Type 1 Diabetics will need an insulin drip
c. Any anticoagulants will have to be reversed (Vitamin K, protamine, FFP, Recombinant VIIa, PCC) Plavix (let urology, anaesthesiology know)
d. Depending on immunological risk, the recipient may require additional therapy such as IviG.

B. Post-op management

You will be called from PACU immediately after the surgery. Patient will have a Foley and an IJ line for monitoring. Urology will continue to follow patient for surgical issues. Pain service will provide patient controlled anesthesia.

1. Ensure that there is urine output.
    - No urine output means:
      - Foley catheter is obstructed
      - ureter is obstructed
      - no blood flow to transplant kidney
      - hyperacute rejection
    - Flush the Foley with saline to dislodge any clots. **If anuric despite this, obtain an URGENT renal ultrasound with arterial dopplers and resistive indices**, and call urology
2. Watch for post-op hyperkalemia. This can be treated with insulin shift and lasix diuresis.
3. The goal for the first 24-48h post-op is to maintain a slightly hypervolemic state to maintain kidney perfusion. Target CVP is 4-7cm. This can be achieved by replacing urine volume 1:1 with IV replacement. ALWAYS START WITH NORMAL SALINE. However and only if there is ongoing polyuria (>200 ml/hour) then to avoid shifts in serum Na we match urine and IV tonicity. (Tonicity = [Na] + [K]).

Example:

Time Post-op	Serum Na	Urine Na	Urine K	IV Replacement
0:00 h 0:30 h	Pending 142	Pending 90	Pending 50	NS 1:1 for U/O NS 1:1 for U/O

4:00 h 8:00 h	138 134	50 50	30 30	1/2NS 1:1 for U/O NS 1:1 for U/O

IV solution	Tonicity
NS	154
1/2NS	77
50% 1/2NS + 50% NS	116

4. Follow serum and urine lytes q6h. If the urine output is large, serum and urine lytes will have to be measured more frequently, eg. q3h.
5. Fluid boluses of NS should be used to treat hypovolemia or falls in urine output. IV K+ should never be considered
6. At 24h the IV fluid replacement can be reduced to ½1/2 of the urine volume. Once the patient is tolerating clear fluids the IV fluid can be stopped and the IJ line removed.
7. Routine post-op transplant ultrasound should be done on POD#3
8. Pharmacist will instruct transplant patient their medication regimen
9. Foley catheter removed POD#5
10. Patient is discharged with follow-up in transplant clinic once renal function had stabilized and is ambulating, eating, and voiding well. Routine urology follow-up is not required unless a ureteric stent was placed intra-op.

C. Post-op medications

All transplant recipients require immunosuppression post-op. You must decide if the transplant needs low-risk or high-risk treatment protocols based upon donor/recipient criteria (see below). There may be ongoing research studies; ask your staff at the start of your rotation.

If there is an ongoing study, call Research Manager (Michelle Nash –pager 685-9775) to assess patient suitability and obtain consent; they will order immunosuppressives if patient is enrolled.

Immunosuppressive regimen

Class	Drug Name
Induction Therapies	Anti-Thymocyte Globulin (Thymoglobulin®)
	Basiliximab (Simulect®)
Calcineurin Inhibitors	Cyclosporine (Neoral®)
	Tacrolimus Extended Release (Advagraf®)
	Tacrolimus immediate Release (Prograf®)
Antiproliferative Agents	Mycophenolate Sodium (Myfortic®)
	Mycophenolate Mofetil (Cellcept®)
	Azathiporine (Imuran®)
mTOR inhibitors	Rapamycin, Sirolimus (Rapamune®)
Corticosteroids	Methylprednisolone (Solu-Medrol®)
	Prednisone
Infection Prophylaxis	Sulfamethoxazole/Trimethoprim (Septra®)
	Valganciclovir (Valcyte®)
Supplementary	Proton Pump Inhibitor
	Iron
	Stool Softener

Induction Therapy:

Low Immunological Risk Transplant:

Basiliximab (Simulect®)

- Most recipients, regardless of cPRA
- no donor-specific anti-HLA antibodies
- no previous allograft loss due to acute rejection

Dosing:

20 mg IV x 1 on-call to OR and 20 mg IV x 1 on POD#4

A steroid sparing protocol may be utilized if the patient:

- has IFG/IGT
- known diabetic not on insulin
- known history of GI bleed/Peptic Ulcers
- known osteoporosis
- history of steroid induced psychosis

Discuss in advance with staff physician.

High Immunological Risk Transplant:

Anti-Thymocyte Globulin (Thymoglobulin®)

Indication:

1. Any chance of a missed or untested donor specific antibody (DSA)
2. +ve flow cross match (need to consider doing the transplant ,or choosing back-up).In addition, would also need IVig.

3. Previous allograft loss because of acute rejection

Dosing:

1. 1.5 mg/kg IV post-op when patient returns to the floor (< 6 hrs post-op).
2. Central line: in 250 mL 0.9% sodium chloride over 8 hours
   Peripheral line: in 500 mL 0.9% sodium chloride over 12 hours
3. Pre-medication prior to dose to prevent hypersensitivity reaction:
   - Diphenhydramine 50 mg IV x 1
   - Acetaminophen 650 mg PO/PR x 1
   - These pre-medications can be discontinued if no reaction after 2 doses
4. Cell counts should be monitored daily during thymoglobulin treatment.
   - Target for absolute lymphocyte count (ALC) < 0.2
   - Excessive drop in WBC or PLT requires decreasing or holding Thymoglobulin dose
5. **Daily order is required** based upon ALC, WBC, and PLT count
6. Duration of Thymoglobulin depends on graft function, usually 5-7 days.

Calcineurin Inhibitor:

Tacrolimus Extended Release (Advagraf®) Dosing (preferred CNI):

- 0.1 mg/kg po daily starting evening of OR or on POD #1
- Trough levels daily starting on POD #2

- Use immediate release formulation (Prograf®) 0.05 mg/kg po bid if patient is unable to swallow by mouth/has NG tube

Cyclosporine (Neoral®) Dosing:

- Given to patients at high risk for developing new onset diabetes or those intolerant to Tacrolimus
- Cyclosporine 3 mg/kg po bid starting evening of OR or on POD #1
- C2 levels daily starting POD #2

Cyclosporine (Sandimmune®) IV:

- IV Cyclosporine is used if the patient is unable to take oral cyclosporine or other oral immunosuppressant agents (i.e: tacrolimus)
- Dose:
  - < 100 mg: dilute in 100 mL D5W or 0.9% sodium chloride
  - 100-500 mg: dilute in 250 mL D5W or 0.9% sodium chloride
- Administered by slow IV infusion over a period of no less than 2 hours, usual administration time is 4-6 hours.
- Can be given via peripheral or central vein
- IV Cyclosporine is associated with anaphylactoid reactions due to polyoxyethylated castor oil vehicle in the solution. Physician to remain on the nursing unit for the first 30 minutes following the start of infusion. Keep anaphylaxis kit at bedside.

Enteric Mycophenolic Acid (Myfortic®) Dosing:

- 720 mg po BID starting evening of OR or on POD#1

Mycophenolate Mofetil (Cellcept®) IV:

- Given to those patients unable to take oral capsule, tablet, or suspension
- Can be given for up to 14 days, patients should be switched to oral Mycophenolate once they can tolerate oral medication

- Dose: 1 gram IV bid in 140 mL of D5W administered by slow IV infusion over a period of no less than 2 hours. Final concentration is 6 mg/mL.
- Can be given via peripheral or central vein

Steroid Dosing:

- Methylprednisolone (Solumedrol®): 2mg/kg IV on-call to OR and then IV q12h x 48
  hours

- Prednisone:
  - POD # 3-7: 1 mg/kg po daily
  - POD # 8-14: 0.5 mg/kg po daily
  - POD # 15 onward: 20 mg po daily until transplant clinic follow up

Others:

- Iron: Ferrous Fumarate (Palafer®) 300 mg po daily
- Stool Softener: Docusate Sodium (Colace®) 100 mg po bid
- GI Symptoms: Pantoprazole (Pantaoloc®) 40 mg po daily
- DVT Prophylaxis: Heparin 5000 units sc bid

Surgical Antimicrobial Prophylaxis

1. All transplant recipients receive surgical prophylaxis:
   - Patients less than or equal to 80 kg: Cefazolin 1 gm IV on call to OR

     OR
   - Patients greater than 80 kg: Cefazolin 2 gm IV on call to OR

OR

- Penicillin Allergic: Clindamycin 600 mg IV on call to OR

Infection Prophylaxis:

CMV:

RECIPIENT CMV	DONOR CMV	LOW-RISK (NO THYMOGLOBULIN)	HIGH-RISK (THYMOGLOBULIN)
+	+	None	**YES (VALGANCICLOVIR)**
+	-	None	**YES (VALGANCICLOVIR)**
-	+	Yes (Valganciclovir)	**YES (VALGANCICLOVIR)**
-	-	**NONE**	**NONE**

Start Valgancyclovir (Valcyte®) 450 mg Tablet POD #3. Dose is based on renal function (see below).

CREATININE CLEARANCE (ML/MIN)	CMV PROPHYLAXIS DOSAGE
60 OR GREATER	**900 MG ONCE DAILY**
40-59	**450 MG ONCE DAILY**
25-39	**450 MG EVERY 2ND DAY**
10-24	**450 MG TWICE WEEKLY**

< 10 (ORAL SUSPENSION ONLY)	**100 MG THREE TIMES WEEKLY**

PCP:

All recipients receive Sulfamethoxazole/Trimethoprim 400/80 mg po daily (Septra® Single Strength) for PCP prophylaxis for 1 year. If patient is sulfa allergic, use Dapsone 100 mg po daily.

Other Post Transplant Medications

1. Pre-op meds should be reassessed after transplant
    a) most medications should be resumed on POD #1
    b) NSAIDs, ACE inhibitors, and ARBs should be held until transplant has normal GFR
    c) renal medications (phosphate binders, calcitriol, erythropoietin stimulating agents) can be discontinued
2. Iron supplements are usually added for approximately 3-6 months post transplant

Therapeutic Drug Monitoring

Tacrolimus (Advagraf® & Prograf®):

- Draw Tacrolimus **trough** level immediately prior to the morning dose at 10 A.M
- Time to steady state after initiation of therapy or after change of dose = 2.5 – 3 days

Target Troughs

TIME OUT FROM TRANSPLANT	TARGET LEVEL (UG/L)
0 – 14 DAYS (1ST 2 WEEKS)	5-8
14 – 90 DAYS (2 WEEKS – 3 MONTH)	4-7
> 90 DAYS (> 3 MONTHS)	4-7

Cyclosporine Oral:

Target C2 Level

- Draw cyclosporine **C_2** level exactly 2 hours after the morning dose at 8 A.M.

TIME OUT FROM TRANSPLANT	TARGET C_2 LEVEL (UG/L)
0 – 30 DAYS	1000 – 1300
1 – 2 MONTHS	1000 – 1300
2 – 3 MONTHS	900 – 1100
3 – 6 MONTHS	800 – 1000
6 – 12 MONTHS	500 – 900
> 12 MONTHS	300 – 600

Cyclosporine IV:

Target Trough

- Draw cyclosporine **trough** level immediately prior to morning dose at 8 A.M

TIME FROM TRANSPLANT	TARGET TROUGH LEVEL (UG/L)
0-1 MONTH	350 – 450
1 – 3 MONTHS	300 – 350
3 – 6 MONTHS	250 – 300
6 – 12 MONTHS	200 – 250
> 12 MONTHS	100 – 200

NOTE:

- **Cyclosporine Oral to IV dose conversion = 3:1**
- **Tacrolimus Oral to Cyclosporine Oral dose conversion =1:75**

D. Delayed graft function

Common causes:

Pre-renal:

- hypovolemia
- post-op complications (pulm embolus, MI, etc)
- tacrolimus/cyclosporine toxicity
- other meds: NSAIDs, ACE inhibitors
- renal artery embolus or thrombosis

Renal:

- venous/ arterial thrombus
- post-ischemic reperfusion injury/ATN
- hyperacute or accelerated rejection

Post-renal:

- ureteric stricture

- lymphocele or urinoma
- hematoma

Investigations:

- assess volume status
- check tacrolimus or cyclosporine levels
- check pre-op cross-match

Obtain transplant ultrasound with dopplers and resistive (ALWAYS DO ULTRASOUND and DOPPLER URGENTLY IF ANURIC)

- indices
- consider transplant biopsy

Management:

- ensure adequate effective circulating volume
- hold any nephrotoxic drugs if possible
- reduce tacrolimus/cyclosporine levels and substitute basiliximab 20mg IV days 1 and 4
- address any specific post-renal complication or rejection

Risk Factors for Post-Ischemic reperfusion/ATN

- prolonged cold-ischemia time
- prolonged (>30 min) warm ischemic time
- DCD donor (likelihood is 75%)
- increased donor age (ECD donor)
- nephrotoxic agents (pressors, contrast dye) in donor
- subarachnoid hemorrhage in donor
- vasculopathy in donor or recipient

E. Complications in transplant patients

General Care of Hospitalized Transplant Patients

1) Most transplant patients are on low doses of prednisone. Consideration must be made for relative adrenal insufficiency:

- severe stress (sepsis, ACS, major surgery)
    - hydrocortisone 100mg IV q8h
    - once stable change to prednisone taper (for example):
        - day 1 50mg
        - day 2 30mg
        - day 3 20mg
        - day 4 15mg
        - day 5 10mg
        - day 6 5mg
- mild to moderate stress (uncomplicated infection, day surgery)
        - triple steroid dose for 3 days

2) Patients who cannot take PO medications can receive some medications IV
    - 1mg prednisone PO -> 4mg hydrocortisone IV (divide dose q8-12h)
    - 3mg cyclosporine PO -> 1mg cyclosporine IV (q12h dosing)
    - Tacrolimus 0.05mg/kg/day continuous IV infusion
    - 1mg MMF PO -> 1mg MMF IV (q12h dosing, no adjustment needed)

3) Nephrotoxic agents should be avoided as much as possible

- avoid radiocontrast dye when possible; premedicate with NAC 600mg PO q12h and IV NS at 75cc/h
- avoid aminoglycoside antibiotics; use fluoroquinolones or cephalosporins instead
- judicious use of NSAID or ACE inhibitors when needed

REMEMBER: Immunosuppressed patients have a reduced inflammatory response to infection and tissue damage. Have a high degree of suspicion for occult infection and order appropriate imaging.

Acute Renal Failure in Renal transplant Patients

Common causes Weeks 1-12:

- Acute rejection
- Acute allograft pyelonephritis
- Tacrolimus/cyclosporine toxicity
- Hypovolemia
- Urinary obstruction (ureteric stricture or fluid collection)
- CMV infection
- Recurrence of primary disease (esp. FSGS and atypical HUS)

Common causes at > 3 months:

- Acute allograft pyelonephritis
- Hypovolemia
- Tacrolimus/cyclosporine toxicity
- Acute rejection
- Recurrence of primary disease
- BK virus nephritis

- Post-transplant lymphoproliferative disorder
- De novo renal disease

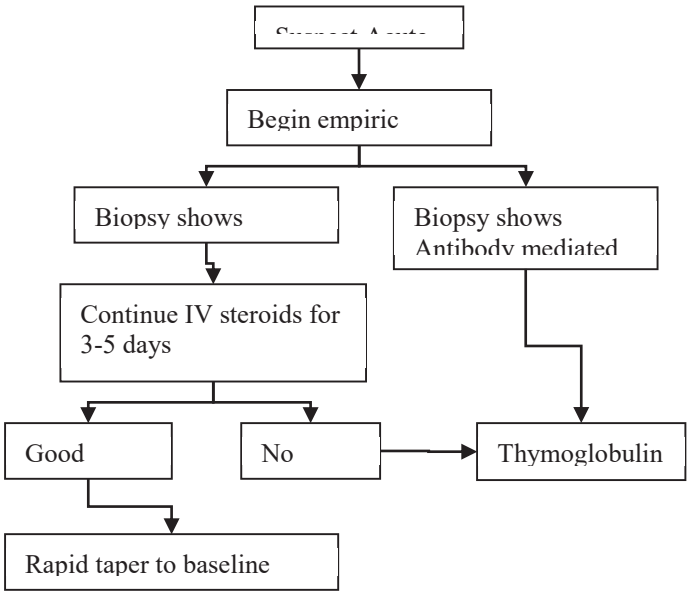
Investigations:

- history focusing on medication changes and adherence, history of CMV or EBV mismatch, and recent illness or volume loss
- physical exam focusing on volume status
- labs including urine electrolytes, urine dip and microscopy for sediment, serum tacrolimus or cyclosporine levels, and routine blood work
- transplant ultrasound with dopplers

Treatment Guidelines for Acute Allograft Rejection

1. Pulse steroids may be given without affecting the diagnostic yield of the biopsy
2. Thymoglobulin is given in the same way as high-risk transplants, with a dose of 2mg/kg IV q24h
    a. Premedicate with diphenhydramine and Tylenol for first 2 days
    b. Ensure gancyclovir IV prophylaxis
    c. Septra for PCP prophylaxis
    d. Nystatin mouthwash
3. Reason for rejection should be addressed
    a. Inadequate immunosuppressive regimen
    b. Decreased tacrolimus/cyclosporine levels
    c. Non-adherence to medications
    d. Drug interactions with immunosuppressants
4. Antibody-mediated acute rejections (denovo DSA, or pathological features, including C4D+, or other findings such as TMA, peri-tubular

capiliaritis) in addition to thymoglobulin will require additional therapies such as plasmapheresis, IVIG, Rituximab.


Begin empiric
Biopsy shows
Biopsy shows
Antibody mediated
Continue IV steroids for
3-5 days
Good
No
Thymoglobulin
Rapid taper to baseline

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THE BEST NEPHROLOGY WEBSITE IN THE WORLD - UKidney.com
(Developed and administered by Dr. Jordan Weinstein)

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