



**RESIDENT ORIENTATION TO  
NEPHROLOGY/TRANSPLANT  
@ SMH**

**July 2004**

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## **INTRODUCTION**

Welcome to Nephrology. In addition to goals and objectives, this outline is merely an outline of some of the practical issues relating to your time on 8CS ward and on the consult service. 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.

### **Nephrology/ Transplant 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
- 2) To understand the conservative management of acute renal failure
- 3) To understand the management of chronic renal failure  
specific rx (eg. Immunotherapy)  
Non-specific rx ( eg. HT control, ACE inhibition, dietary protein intake, etc.)  
symptomatic rx ( eg. Diuretic therapy )
- 4) To understand drug therapy of hypertension, and an approach to renal artery disease
- 5) To understand the indications for dialysis
- 6) To understand the basic concepts regarding selection of dialysis modality
- 7) To understand the basic components of dialysis orders  
ultra filtration vs dialysis

## **Transplantation**

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

## **B) Choice and Use of Ancillary Tests eg. Laboratory Tests**

- 1) To understand and develop an approach to common fluid electrolyte and acid base problems  
hypo & hypernatremia, hypo & hyperkalemia, metabolic acidosis & alkalosis
- 2) To be able to perform a competent microscopic urine examination, and to understand the assessment of renal function with serum creatinine and creatinine clearance
- 3) To understand the workup of hematuria and proteinuria
- 4) 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 eg. Methanol, ASA
- 3) Management of hypertensive emergencies
- 4) Competence in securing temporary vascular access for hemodialysis

## **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) Indications for slow dialysis in intensive care patients

## **Nephrology Physicians:**

All Nephrology Staff available through hospital locating.

	<b>Office #</b>	<b>Pager #</b>	<b>Location</b>
Dr. M. Halperin	864-5292		38 Shuter
Dr. M. Goldstein#	864-5290	685- 9373	3DN 7-1230
Dr. S. Donnelly	867-7467	336-1217	7th floor, 61 Queen
Dr. K. Kamel*	867-7479	685-9085	9th floor, 61 Queen
Dr. J. Zaltzman	867-7444	685-9336	9th floor 61 Queen
Dr. P. Marsden	988-2441	685-9489	MSB
Dr. S. Quaggin	586-8266	685-9166	MSH
Dr M .Schreiber	867-7454	685-9644	9th floor 61 Queen
Dr. P. McFarlane	867-3702	667-5075	9 <sup>th</sup> Floor 61 Queen
Dr. R. Prasad	867-3722	685-9637	9 <sup>th</sup> Floor 61 Queen
Dr. A. Selick	864-5228		8 CS;Nephrology Clinical Associate
Dr. Jordan Weinstein		866-0364	8CS;Nephrology Clinical Associate

# Medical Director of DCCP

\* Division Head

**Program Director DCCP: Bea Mudge 864-5791**

**IN PATIENT WARD 8 CS 864-5097**

**TRANSPLANT OFFICE : Manager:** Janice Ritchie Carrabau 5546  
**9th Floor, 61 Queen (JIM)** 867-3665  
Miriam Jayoma Transplantation 867-8179  
Gallo Meliton Transplantation 867-3677  
Fernanda Shamy Transplantation 867-3676  
Jenny Huckle Transplantation 867-8040

**In Patient Nephrology/Urology/**

8CC: 5097

**Manager : Desa Hobbs** 5293

**Transplant Surgeons:**

Dr. Honey (Chief of Urology) 867-3705 pager 685-9099

Dr. Stewart (Surgical Director) 867-3686 pager 685-9082

Dr. Ken Pace 867-8038 pager 685-4599

**Transplant Nephrologists:**

Dr. Zaltzman 867-7444 pager 685-9336

Dr. Prasad 867-3722 pager 685-9637

**Social Work:**

Sharon Lee HD 864-4173 pager 685-9181

Denise Cherrier 61Queen/Tx 867-3706 pager 685-9246

Michel Verdierme PD/PRI/Tx 864-4193 pager 685-9626

Jacinda Thompson-Fraser

**Dieticians:**

Carol Huang HPDU/9Q pager 685-9376

Karen Burleigh 8CC/TXP pager 685-9432

Donna Lum 8CC pager 685-9921

**Pharmacist:**

Salma Bhaloo 8CC/TXP pager 685-0108

Diane Chong HEMO

Andrea Fox 8CC

Lori McCallum Home Dialysis/PRI

**Hemodialysis Unit:** Manager Jill Campbell 5293  
8CC and 4DN, Dr. M. Goldstein , Dr S. Donnelly 5228

**Home Dialysis:** 8CC 5794 /5741  
Dr. P. McFarlane  
Dr. M. Goldstein ,  
Dr S. Donnelly

**Home dialysis Nurses:** 5794 pager 685-9682  
Joyce Hunter  
Mina Kashani  
Julie De La Cruz  
Beth Unana

Other:

**RENAL BIOPSIES**

Dr. Jothy; Renal pathologist # 2921 ( Note all biopsies are done by Interventional Radiology # 5886). Please fill out pathology biopsy form on ward, 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 in advance

**LINES, Biopsies, PD Catheter manipulation @ Interventional Radiology # 5886**

## **Nephrology Rotation (Service Chief: Dr Jeff Zaltzman)**

### **NEPHROLOGY HOUSESTAFF RESPONSIBILITIES:**

The Nephrology rotation is a combined inpatient ward, consult and ambulatory clinic experience.

There is a strong teaching component. 8 am teaching sessions Mon-Thursday, Friday ; 12 pm

During a two-month rotation, the 5 nephrology house staff will be divided into two teams of 3 & 2 residents. Each team will spend one month on the nephrology ward (8CS), and one month on the consult rotation.

Those only doing one month may not be able to get their choice, as team assignments will be based on needs and vacation times.

Each team will have as its leader a Nephrology Trainee, in addition to an attending Nephrologist.

Formal rounds with the attendings will take place twice weekly, usually Monday and Friday mornings, although there can be some flexibility to accommodate attending, house staff and fellow needs.

**IT IS EXTREMELY IMPORTANT THAT MORNING SIGN-OVER and EVEVNING SIGN-OUT TAKE PLACE WITH BOTH TEAMS PRESENT, AS THE ON-CALL RESIDENT MUST BE FAMILIAR WITH ALL WARD AND CONSULT PATIENTS.**

**GIVEN VACATIONS, POST-CALL, CRISP and HALF DAY BACK CLINICS; IT IS FORSEEABLE THAT THE HOUSESTAFF NUMBERS ON ONE OF THE TEAMS COULD AT TIMES BE AS LOW AS ZERO. THEREFORE, IT IS EXPECTED THAT DURING THOSE TIMES THE TEAMS WILL “CROSS-COVER” FOR EACH OTHER: REMEMBER THAT PATIENTS’ CARE COMES FIRST!**

During the ward/clinic 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.

## WARD

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

All admissions should be admitted under the Attending Staff Physician that month, or the Attending Staff Physician On Call over the weekend.

Discharges should be planned the night prior to discharge with notification of patient and nursing staff.

There is a daily meeting at 8:00 AM(or earlier on teaching mornings)on 8 CS, of all the Nephrology Housestaff and the Ward Attending Physician, to ensure adequate transfer of tasks and responsibilities. Bullet rds with team and 8CS staff occur each Am ~9:30 to discuss and plan in-patient disposition. Brief team/staff meetings as need arises to review problem cases, new consults.

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

- It is of utmost importance that discharge summaries be dictated immediately upon discharge, with copies sent to family physicians, referring internists and staff.

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**Notes regarding Transplant, Hemodialysis, Peritoneal Dialysis patients are to be dictated STAT, with copies to be sent to the respective units.**

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

## CONSULTS

The Consult Service offers the opportunity to deal with renal or fluid and electrolyte disorders in a patient who is on another service. Many consults come from the critical care units where acute renal failure 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. Acute renal failure & critical care patients 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.

### **Microscope on 8CC for urinalysis**

**ALL RESIDENTS WILL PRESENT A FORMAL POWEPOINT FRIDAY RDS ON A TOPIC. USUALLY ~35 min PRESENATATION**

Goals:

- 1) to develop an expertise in 1 area of nephrology/transplant
- 2) to gain expertise in formal presentation skills
- 3) to teach your peers

Dr. Jeffrey S. Zaltzman  
Educational Director

**DIVISION OF NEPHROLOGY  
CLINICAL & TEACHING ACTIVITIES - 2004**

<b>DAY</b>	<b>TIME</b>	<b>ACTIVITY</b>	<b>PLACE</b>
<b>MONDAY</b>	*8:00 – 9:00	Morning report	8 Cardinal Carter Wing
	!9:00 - 11:30	Ward Rounds/Consult RDs	8 Cardinal Carter Wing
	12:00-17:00	Nephrology Clinic-Dr. Schreiber	61 Q 9 <sup>th</sup> Fl
<b>TUESDAY</b>	8:00 - 9:00	Basic Science Rds,/M&M	8 Cardinal Carter Wing
	9:00 - 12:00	Progressive Renal Disease Clinic	61Q 9th Fl
	9:00 – 12:00	Nephrology Clinic Dr. Zaltzman	61 Q9th Fl
	13:00 – 16:30	Nephrology Clinic-Dr. Kamel Nephrology Clinic (Dr. Dr. Donnelly, )	61 Q 7 <sup>th</sup> fr
<b>WEDNESDAY</b>	8:00 - 9:00	Teaching Seminars	8 Cardinal Carter Wing
	9:00 - 12:00	Nephrology Clinic-Dr. Zaltzman Multidisciplinary Diabetes Clinic	61Q 9 <sup>th</sup> Fl 61 Q 7 <sup>th</sup> Fl
	12:00 - 13:00	Medical Grand Rounds	Queen St auditorium
<b>THURSDAY</b>	8:00 – 9:00	Dr. Halperin Teaching	8 Cardinal Carter Wing
	8:30 - 11:00	Transplant Clinic	61Q 9 <sup>th</sup> Fl
	12:00 – 1:00	q2 weeks Bench to Bedside Dr. Marsden et al.	7Vic conf rm
	9:00- 16:00	Nephrology-Dr. Goldstein	3 Shuter
	13:15-16:30	Stone Prevention Clinic	61Q 9 <sup>th</sup> Fl
<b>FRIDAY</b>	8:00 - 8:30	Sign-over	8CC Ward
	9:00 - 11:30	Ward Rounds/ Consult Rds	8CC Ward
	9:00 – 12:00	Multidisciplinary Diabetes Clinic	61Q 7th Fl
	12:00 - 13:00	Resident Renal Rounds – all staff/Biopsy Rd q2mth	3E Conf. Room

- **\*on teaching days, residents should meet for sign-over at 7:45, before teaching rounds**
- **! Bullet rds with ward team, nurses, SW, manager etc. ~ 9:30**

## Outpatient Clinics

Every week there are Outpatient Clinics that have been organized to allow Resident participation:

### OUT PATIENT CLINICS AND OFFICES

	Mon,	Tues	Wed,	Thurs,	Fri,
A M	<b>Transplant Clinic</b> (Dr. Prasad) 61 Queen, 9 <sup>th</sup> flr (9:00-12:00)	<b>-PRDC Clinic</b> (Dr. Goldstein Dr. Donnelley)	<b>-MDCC Clinic</b> (Jackie Chen, RN) 61 Queen, 7 <sup>th</sup> flr (8:00-12:00)	<b>Nephrology Clinic</b> (D Prasad) or (9:00-12:00) Dr.. Goldstein all day 3 Shuter	<b>PRDC</b> (Dr. Prasad) 61 Queen, 9 <sup>th</sup> flr (9:00-11:30)
P M	----- ----- <b>Nephrology Clinic</b> (Dr. Schreiber) 61 Queen, 9 <sup>th</sup> flr (11:30-5:00)	<b>-Nephrology Clinic</b> (Dr. Zaltzman)or ( Dr. Kamel) 61 Queen, 9 <sup>th</sup> flr (9:00-12:00)	<b>-Nephrology Clinic</b> (DR. Zaltzman) or ( Dr. Kamel) 61 Queen st. 9th	<b>Transplant Clinic</b> (Dr. Zaltzman) 61 Queen, 9 <sup>th</sup> flr (9:00-12:00) <b>Nephrology</b> Dr. Goldstein3 Shuter 8-16:00	-----
		<b>Nephrology clinic</b> Dr. Donnelly 61 Queen st 7 <sup>th</sup> flr	--	<b>Renal Stone Clinic</b> (Dr. Schreiber) or ( Dr. Kamel) 1 Queen, 9 <sup>th</sup> flr (1:00-4:00)	
		<b>Home dialysis</b> Dr. McFarlane 6 Queen st 9 <sup>th</sup> flr			

**Each resident will be sent an e-mail from Michelle Gotwald ( 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.

## **Educational and Research Opportunities**

During the rotation, Trainees are encouraged to take advantage of the opportunity for discussion with Staff persons who have expertise in the different aspects 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 more advanced bench type research. All of the staff encourage residents to participate in research endeavors and would be all too happy to help supervise a project. These projects could be presented at the annual St. Michael's Resident Research day (Higgin's Day). In the past the staff of the Division of Nephrology at St. Michael's has been proud to assist residents in not only presenting their work locally but also in many cases at International Conferences.

Dr. Halperin	Acid-Base and Electrolyte Physiology
Dr. Goldstein	Acid-Base and Electrolyte Physiology, Hemodialysis
Dr. Kamel	Acid-Base and Electrolyte Physiology and stones,
Dr. Zaltzman	Transplantation
Dr. Marsden	Molecular Medicine and Hypertension
Dr. Quaggin	Molecular Medicine, Glomerulonephritis
Dr. Donnelly	Hemodialysis, Diabetes
Dr. McFarlane	Diabetes, Nephrology Clin Epi
Dr. Prasad	Transplantation
Dr. Schrieber	Medical Education/Renal Physiology

## HEMODIALYSIS

**HBsAg must be done first, prior to treatment and results known.** If a patient may need dialysis in the foreseeable future, do the HBsAg.

A written consent must be obtained by the physician for line insertion and hemodialysis.

**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 bloodwork orders to avoid cephalic vein.

The hemodialysis unit is located on 8CC (a second unit is on 4- Shuter ; plan for dismantling in 2005)

Hours are 7:30 –22:00

Some patients are dialyzed overnight on the 8CC ward.

Typically 3 shifts of patients per day, most common practice for chronic in-center HD patients are thrice weekly dialysis, Mon,Wed,Frid, or Tue,Thurs,Sat

Dialysis nurse is available on call after hours and on Sundays for emergency dialysis cases. If a nurse is required to come in, this decision should be undertaken with renal resident and attending nephrologists

### **Resident responsibilities for chronic HD patients**

Residents are **not** responsible for daily HD patients as there are Renal staff and Renal trainees involved in the care of these patients. Residents **are** responsible for in-patients who are on dialysis ( acute or chronic pts) issues, particularly in terms of writing orders. In addition, admissions from the dialysis unit will be directed to the residents. Lastly, residents need to respond urgently to acute issues for dialysis patients on the “last shift”, or for overnight patients on the ward, if the attending dialysis nephrologist has already left.

## DIALYSIS ORDERS

Need to be written in advance ( a day ahead if possible) for all acute patients, and all chronic hemodialysis patients admitted to hospital. For stable chronic in-patients, orders can be written once/per week unless changes are required.

Orders can be written in chart:

- 1) **Dialyser:** usually F80 for acutes
- 2) **Time:** for chronic patients 3-4 hours is typical (new patients may need more frequent but less time on dialysis)
- 3) **Blood pump speed;** usually as tolerated ( nurses can decide) 300-450 ml/ min  
**New Acute and/or very uremic patients need much slower speeds ~200 ml/min, and short duration ~ 2hours.**
- 3) **[Na<sup>+</sup>] in dialysate :** usually 140 mmo/l but can ‘ramp’ ie; [Na<sup>+</sup> ] from ~160>155>150>145> 140 mmol/l
- 4) **[K<sup>+</sup>]in dialysate: 1.5, 2.5 or 3.5 mmol/l.** In general the higher the plasma [K<sup>+</sup>], the lower the bath
- 5) **Ultra filtration : refers to amount of net fluid removal per given dialysis.**  
Usual target is to achieve patients’ target or dry weight (weight without any extra ECF volume). However this may not always be possible. For example a patient with severe edema who is hypotensive can never have his/her extra volume removed on a single dialysis session. Orders ca be written in terms of a) target weight or b) litres removed
- 6) **BP support** usually important in ICU setting. Can involve ramping Na, NS, blood, albumin, pentaspan or inotropic support. Sometimes “wrapping of limbs”. Most often done by reducing BPS, or reducing UF.
- 8) **Heparin** standard anticoagulation.
  - a) Normal : 5000 unit bolus followed by 1000 units/hour until ~ 30 min prior to end of HD

b) Minimal : as above, but with no bolus

c) None

Heparin orders will depend on risk of bleeding. Clearly for patients with active bleeding or at high risk for bleed, then the heparin choice should be none

9)**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 Hemodialysis**

### **1) AV Fistula**

Surgical anastomosis of patient's artery to vein. Matures in 6 weeks to 3 months. Feel a thrill, and hear a bruit. Best type of vascular access

### **2) AV Graft**

Connection of artery to vein using "Gortex", usually upper arm, or thigh

Can be used within 1 month

Problems with thrombosis and infection

The above accesses are used for chronic HD. IVs and Bps should be avoided in the ipsilateral arm

### **3) Central venous catheters**

a) **temporary** and placed by residents. These are double lumen catheters placed in femoral vein, or internal jugular vein. Used when dialysis is urgently required. Can use "Site Rite" for assistance with guidance. Heparin (1:10,000) required in each lumen. Check volume of lumen. Need CXR for IJ line placement in SVC or R atrium

b) **permanent** Usually "Udal Cook" or other brand type  
Tunneled catheter inserted by interventional radiology under fluoroscopy  
This is the preferred method for central venous catheters. Can usually get on day of request, by calling radiology at # 5886 with requisition

Central venous lines are least preferred access. The advantage is that they can be used immediately. Risk of thrombosis, infection, less adequate dialysis

## **Line Infections**

### **Most common source of fever and sepsis in HD patients**

Need blood culture and C&S from exit site

Empiric Therapy with Ancef 2 gm IV consider adding gentamycin in very toxic looking patients

Further dosing is usually done post-HD for 1-2 weeks

Adjust antibiotics based on C&S

Recurrent line infection or very sick patients should have line removed

Continuous Renal Replacement Therapy
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**Continuous Venovenous HemoDialysis/ Hemodiafiltration:  
Policy for Initiating and Restarting the Therapy**

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Continuous venovenous hemodialysis (CVVHD) and continuous venovenous hemodiafiltration (CVVHDF) are two forms of continuous renal replacement therapy used in the management of acute renal failure (ARF) in Critical Care Areas. The major benefit of both therapies is the slow and continuous nature that enables its use in the hemodynamically unstable patient. Since it is a slower form of therapy, neither therapy should be viewed as a “Life Saving” treatment; therefore, its institution is usually not an emergency.

**INDICATIONS FOR CVVHD:**

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- patients who require acute haemodialysis and are haemodynamically unstable to the point where conventional haemodialysis is very difficult.
- patients with very large ultra filtration needs, coupled with large IV infusion rates

**INSTITUTION OF CVVHD:**

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CVVHD, under most circumstances, should be instituted during the day (0900-1700 hrs). Under unusual circumstances, it may be instituted between 1700-2300 hrs, but rarely after 2400 hrs.

- If a patient **urgently** requires haemodialysis after 2400 hrs, they are usually best treated with conventional haemodialysis.

- If a patient needs **urgent ultra filtration**, a viable option is **phlebotomy**, followed by packing of the RBCs, which can then be re-administered with a second phlebotomy if needed. This can be achieved much quicker than the institution of CVVHD.

In cases where there is dispute as to whether CVVHD/CVVHDF should be instituted, the problem should be resolved at the Attending Staff level. The Nephrology **ATTENDING STAFF** must be involved in the decision to institute CVVHD/CVVHDF or to re-institute the process in the night.

### **TEMPORARY DISCONNECTION:**

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If the patient is to have a procedure, necessitating leaving the ICU, the Haemodialysis Unit should be notified **as early as possible**, to facilitate the planning of a timely disconnection.

The patient will be re-transfused; the catheter will be flushed, heparinized and capped. The Prisma will be primed and re-circulated until the patient returns. Upon the patient's return, the Haemodialysis Unit should be contacted and arrangements made for the patient to be reestablished on CVVHD.

### **REINSTITUTION:**

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If the CVVHD/CVVHDF circuit clots after 2400 hrs, the system should be disconnected, the catheter should be flushed with saline, heparinized and capped.

### **ANTICOAGULATION AND REINSTITUTING CVVHD:**

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Prior to restarting CVVHD/CVVHDF, the anticoagulation being delivered to the circuit should be reviewed to ensure that any required changes are instituted prior to the reinstatement of the therapy. The Haemodialysis Unit should be notified in the morning and the treatment will be resumed. **STANDARD ANTICOAGULANT IS HEPARIN**

Under most circumstances, the patient will be well dialyzed, will have a normal ECF volume and therefore will not be disadvantaged by the interval without dialysis. Their drugs and IV solutions should be reviewed in light of receiving no dialysis for the subsequent period.

- Patients with no bleeding risk should be anticoagulated so that their PTT is twice their baseline level.
- Patients with a moderate bleeding risk should have their PTT 1.5 times their baseline coupled with pre filter infusion of replacement solution.
- Patients with a serious coagulopathy could be considered for CVVHDF, which delivers with prefilter hemodilution or replacement fluid and no heparin.

## **CRRT Using Regional Citrate Anticoagulation: Initiating the Therapy**

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### **PURPOSE:**

1. Provide continuous fluid removal and dialysis for patients at high risk of bleeding such as those who have had recent surgery, active/recent bleeding or thrombocytopenia.
2. Anticoagulate the extracorporeal circuit without increasing the patient's risk of bleeding.
3. To initiate CRRT on a patient with an external vascular access ie. dual lumen subclavian, internal jugular or femoral catheter.
4. To ensure patient safety by minimizing potential complications associated with initiating dialysis. For example:
  - i) air embolus
  - ii) introduction of clot into vascular system
  - iii) exsanguination
  - iv) infection due to contamination
  - v) inappropriate infusion of ACD-A
  - vi) inappropriate infusion of calcium chloride

### **Equipment:**

Prepared Prisma circuit in CVVHDF mode

Supplies for accessing external vascular catheter

- 2 three way stopcocks OR a two-gang stopcock
- 2 10 ml syringes
- 2 blue clamps
- 1 ampoule of potassium chloride

### **Method:**

#### **Intensive Care Unit Nurse Responsibility:**

1. **ACD-A Preparation:** Obtain a 1L bag of ACD-A and the appropriate tubing for the volumetric infusion pump. Spike the ACD-A bag and prime the tubing. Load it into the infusion pump.

2. **10% Calcium Chloride Preparation:**
  - i) **To a 1L bag of D5W, add 8 g calcium chloride. Label this bag.**
  - ii) **Connect the primed tubing to a volumetric infusion pump prior to attaching it to a central line.**  
**Ensure tubing is appropriate for infusion pump.**
3. Flush a two-gang three-way stopcock with normal saline.
4. Set infusion rates for ACD-A and calcium chloride as prescribed by the physician.

### **Hemodialysis Nurse Responsibility**

5. Replace bags on the effluent, dialysate and replacement scales.
6. Add potassium chloride to each bag of dialysate containing Normocarb and label.
7. Conduct a baseline assessment of the patient.
8. Access the vascular catheter as per procedure for Initiation of Hemodialysis via External Vascular Access. If unable to aspirate from arterial/access port of catheter, reverse the lines before initiating the treatment. (That is, return line will be connected to red port of the catheter, and access line (with the stopcocks) will be connected to the blue port of the catheter. Pay attention to the access, return and filter pressures upon initiation of CRRT.)
9. Attach primed stopcock to the access/arterial limb of the catheter. **Note:** *The use of 2 stopcocks in series will provide 3 infusion ports: one for saline flush, one for ACD-A (citrate) infusion and the other for the access blood line.*
10. Ensure that primed ACD-A and saline infusion lines are connected to each port of stopcock. The infusion line with ACD-A must be connected to the stopcock closest to the dialysis catheter.
11. Clamp access and return blood lines. Use a blue clamp to clamp the priming bag.
12. Connect access blood line to the stopcock.
13. Connect return line to venous/return limb of the dialysis catheter.

14. Place ONE of the 3L dialysate bags on the dialysate scale. Place the other bag on the hook at the left side of the Prisma machine. Clamp the limb of the Y-connection leading to it. (Placing two 3L bags of dialysate on the scale is too heavy for the scale. This has resulted in the inappropriate removal of fluid from the patient.
15. When ready to initiate CRRT, inform the ICU nurse so that you can co-ordinate the simultaneous start of the Prisma, with initiation of ACD-A and calcium chloride infusions.

**Documentation:**

1. Baseline patient assessment as indicated in spaces provided on CRRT flowsheet:
  - a) vital signs and other relevant patient assessments
  - b) baseline blood work collected
2.
  - a) Dialysate additives
  - b) infusion rates of ACD-A and calcium chloride
  - c) blood flow, replacement and dialysate flow and fluid removal rates
  - d) pressures: access, effluent, filter, and return
  - e) fluid to be removed

Developed: July 8, 2002

**Physician's Orders For Continuous Renal  
Replacement Therapy (CRRT)  
Using Regional Citrate Anticoagulation**

**All routine orders and checked orders (  ) will be transcribed.  
Orders not to be transcribed must be crossed out and initialed.  
Generic equivalent drug may be dispensed under formulary system.**

ALLERGIES: <input type="checkbox"/> YES <input type="checkbox"/> NO
---

DATE / TIME	CONTINUOUS RENAL REPLACEMENT THERAPY USING REGIONAL CITRATE ANTICOAGULATION
	<p><b>MODALITY OF CRRT: <input type="checkbox"/> Continuous Venovenous Hemodiafiltration (C.V.V.H.D.F.)</b></p> <p style="text-align: center;"><b><u>ONLY to be used for regional citrate anticoagulation</u></b></p>
	<p><b>1. BLOOD FLOW RATE:</b> .....mL/min (suggested starting rate 100 mL/min)</p>
	<p><b>2. DIALYSATE FLOW RATE:</b> start at .....mL/hr (suggested starting rate 20 mL/kg/hr)</p> <p><b>3. DIALYSATE SOLUTION: Normocarb™</b> (bicarbonate based, calcium free, potassium free)  <b>Note:</b> To prepare Normocarb™, add 240 mL of Normocarb™ to <b>each <u>3.0 L bag of sterile H<sub>2</sub>O for irrigation</u></b> and mix gently</p>

**4. DIALYSATE ADDITIVES to Normocarb™**

**If serum K<sup>+</sup> is:**

**greater than or equal to 6.0 mmol/L, do NOT** add KCl to 3.0 L bag with Normocarb™

**5.1 to 5.9 mmol/L, add 9 mmol KCl to each 3.0 L bag with Normocarb™ to obtain a K<sup>+</sup> concentration of 3.0 mmol/L in the dialysate**

**less than or equal to 5.0 mmol/L, add 12 mmol KCl to each 3.0 L bag with Normocarb™ to obtain a K<sup>+</sup> concentration of 4.0 mmol/L in the dialysate**

**5. REPLACEMENT SOLUTION:** Set up Prisma® with normal saline

**6. REPLACEMENT FLOW RATE:** Start at 0 mL/hr (See #11- Replacement Fluid Infusion Rates on page 3)

**7. SALINE FLUSH (100 mL)** prn to visualize circuit. Add saline flush volume to fluid removal rate

**8. PATIENT ULTRAFILTRATION RATE (UFR): Aim to remove**  
..... to ..... mL/hr

to 200 mL/hr)

(usual range 50

**Note: On the Prisma®, set fluid removal rate = patient UFR + citrate infusion volume + calcium chloride**

**infusion and bolus volumes + saline flush volumes when given**

**MD Print Name:**

**MD Signature:**

**Date:**

Patient ID

<sup>3</sup>  
ALLERGIES:     YES     NO

**9. REGIONAL CITRATE ANTICOAGULATION:**

**i) CITRATE (ACD-A\*) infusion rate at: .....ml/hr (suggested starting rate 150 mL/hr)**

Use sliding scale 10a, based on *CIRCUIT* ionized calcium taken from blue return sample port to titrate

(\*ACD-A means Anticoagulant Citrate Dextrose Formula A)

**ii) CALCIUM CHLORIDE infusion, 8 g in 1 L D5W, via central line, rate at: ..... mL/hr**

**(suggested starting rate 50 mL/hr).**

Use sliding scale 10b, based on *PATIENT'S* ionized calcium taken from patient's arterial line

**iii) STOP THE CITRATE AND CALCIUM CHLORIDE INFUSIONS when the Prisma® blood pump stops.**

After the alarm condition has been corrected and blood flow has resumed, restart citrate and calcium chloride infusions.

**10a. CIRCUIT**  
 Sampled from Blue Return  
 Sample Port on the Prisma®

Ionized calcium (mmol/L)	Citrate Infusion Rate
less than 0.25	decrease by 10 mL/hr
<b>0.25 to 0.35 (target range)</b>	<b>no change</b>
0.36 to 0.45	increase by 10 mL/hr
greater than 0.46	increase by 20 mL/hr
<b>Notify MD if citrate infusion rate is greater than 200 mL/hr</b>	

**10b. PATIENT**  
 Sampled from Patient's Arterial Line

Ionized calcium (mmol/L)	Calcium chloride (CaCl <sub>2</sub> ) Infusion Rate
less than or equal to 0.75	<b>Notify MD and stop citrate infusion for 2 hours</b>
0.76 to 0.84	increase by 15 mL/hr + 1g Calcium Chloride bolus*
0.85 to 0.94	increase by 10 mL/hr + 1g Calcium Chloride bolus*
0.95 to 1.04	increase by 5 mL/hr + 1g Calcium Chloride bolus*
1.05 to 1.10	increase by 5 mL/hr
<b>1.11 to 1.20 (target range)</b>	<b>no change</b>
1.21 to 1.30	decrease by 5 mL/hr
1.31 to 1.44	decrease by 10 mL/hr
greater than or equal to 1.45	decrease by 15 mL/hr

**\*Note: Calcium Chloride bolus must be mixed in 100 mL D5W and infused over 60 minutes via central line. Follow-up blood work (ionized calcium from circuit and patient) must be taken at least 4 hrs later. Volume**

**MD Print Name:** \_\_\_\_\_

**MD Signature:** \_\_\_\_\_

**Date:** \_\_\_\_\_

**ALLERGIES:**     YES     NO

**11. REPLACEMENT SOLUTION FLOW RATES:**

Start treatment with replacement flow rate at 0 mL/hr.

**If patient's serum bicarbonate is greater than 30 mmol/L and/or serum sodium is greater than 145 mmol/L**

**see replacement solutions and flow rates to be used below:**

**a) If serum bicarbonate is greater than 30 mmol/L:**

Start replacement fluid infusion rate at 200 mL/hr using normal saline on the replacement fluid scale (purple).

**b) If serum sodium is greater than 145 mmol/L with the use of replacement fluid:**

Hang a 1L bag of normal saline y-connected to a 1L bag of 0.45% NaCl on the replacement fluid scale (purple).

**Set replacement fluid rate to 200 mL/hr. Infuse both solutions simultaneously.**

	<p><b>12. BLOODWORK:</b></p> <p>a) Baseline bloodwork: CBC, electrolytes, glucose, urea, creatinine, PO<sub>4</sub>, ionized calcium, Ca<sup>+2</sup>, Mg<sup>+2</sup>, albumin  <b>If patient ionized calcium is less than 1.11 mmol/L, notify Nephrology to address this level before treatment is started.</b></p> <p>b) <b>BID:</b> electrolytes (<i>q6h, if K<sup>+</sup> greater than or equal to 6.0 mmol/L</i>), CBC, glucose, urea, creatinine, PO<sub>4</sub>, Ca<sup>+2</sup>, Mg<sup>+2</sup>, albumin</p> <p>c) Collect ionized calcium from blue <i>return sample site (label as <b>CIRCUIT calcium</b>)</i> <b>and</b> from <i>patient's arterial line (label as <b>PATIENT serum calcium</b>)</i> at the <u>SAME time</u>.</p> <p>d) <b>Check <i>CIRCUIT</i> and <i>PATIENT</i> ionized calcium levels at the following intervals:</b></p> <ul style="list-style-type: none"> <li>i) One hour after the treatment has been initiated,</li> <li>ii) q4hr after a calcium chloride bolus</li> <li>iii) q4hr x 48 hrs</li> <li>iv) then q6h if circuit and patient ionized calcium levels are stable</li> </ul> <p>e) <b>When blood work results become available,</b>  <b>Review sliding scales</b> for Ca<sup>+2</sup> (ionized AND total calcium levels), HCO<sub>3</sub><sup>-</sup> and Na<sup>+</sup>  Adjust infusion of citrate, calcium chloride and replacement fluids as indicated. (See 10a, 10b, 11a, and 11b.)</p> <p>f) Calculate Citrate Gap on CRRT flow sheet when results of ionized AND total calcium levels are available</p>
	<p><b>13.</b> Check patient's ionized calcium levels every 4 hours x3 after CRRT has been discontinued.</p>
	<p><b>14.</b> Weigh patient every morning</p>

	<b>MD Print Name:</b>
	<b>MD Signature:</b>
	<b>Date:</b>

## Management of Intoxication

All poisonings should be managed with the supervision of renal fellow and staff Nephrologist.

### Hemodialysis

- For solutes that have low MW, not protein bound, water soluble
- Concurrent: renal failure, acid-base disturbance, electrolyte or volume abnormality correctable by dialysis
- Requires vascular access (ideally 2) and anticoagulation

### Hemoperfusion

- Blood passes through a cartridge w/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 (ideally 2) and anticoagulation

### Methanol

- Industry solvent/ 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
- Restless, dyspneic (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 amt 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 landmarks. An anion gap metabolic acidosis with an osmolar gap between measured and calculated osmolality is

classic (calculated osmolality =  $\text{Na} \times 2 + \text{urea} + \text{glucose}$ ). The difference represents the mosmoles of methanol and can be used to guess the level until levels are available.

## Management

- Hemodialysis and Ethanol
- 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
    - Aim for plasma ethanol concentration of 20-25 mmol/L
    - **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 pt is stable for transport (very costly)
- Not for routine use at UHN
- Hemodialysis
  - Hemodialysis indicated for serum methanol levels  $> 10$  mmol/L, or even at lower levels if anion gap metabolic acidosis is present.
  - Insert 2 catheters – in separate venous sites, use F80 (lge surface area) dialyzer and dialyze at Qb of 300 or more
  - Dialysis tech to add ethanol to dialysate 260 mL of absolute ethanol (95%) to 5L of acid concentrate (this is to avoid blood ethanol from being dialyzed out).
  - Dialysis often needed for  $> 10$  hours. Change dialyzer 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.
- 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 of ethanol and methanol q 3-4 hourly with the aid of a chart.

### Ethylene Glycol

- Component of antifreeze and solvents. Dialysis indicated for level > 6 mmol/L or lower levels with anion gap met acidosis
- T<sub>1/2</sub> 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 + dialysis.

### 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 F80 (large, high flux), max blood flow, min 4 hours
- HP – use charcoal cartridge, saturates in about 2 hours, must change cartridge 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
  - Indications: Li level > 4.0 meq/L
  - Li level >2.5 meq/L if symptomatic or renal insufficiency
  - Goal: sustained level 1 meq/L 8 hrs post HD
- Dialyze 8-12 hours and monitor post plasma Li levels q4h for 36 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 alkalinization urine: goal urine PH >7.5
  - Hemodialysis
    - Indications: Salicylate level > 7 mmol/L
    - Seizures/coma
    - Severe metabolic acidosis, esp. with RF
    - Non cardiogenic pulmonary edema
    - Esp if elderly, smoker, acute on chronic ingestion

**Poison Control Telephone Number: (416) 813-5900**

## **PERITONEAL DIALYSIS AT SAINT MICHAEL'S HOSPITAL**

### **CAPD (Continuous Ambulatory Peritoneal Dialysis)**

Order volume of exchange, frequency of exchanges, additives (usually none) target weight specifying whether or not the target weight includes the exchange volume (ie dry or full). The majority of patients are weighed in the filled state and this volume should be incorporated into the target weight accordingly.

For example, CAPD: 2.5 litre volumes qid with 3 mEq KCl/litre  
Target weight 68 kg (full with 2.5 L)

For diabetics order frequency of capillary blood glucose monitoring (usually coincides with exchanges but may be reduced in stable patients).

### **CCPD (Continuous Cyclic Peritoneal Dialysis)**

Continuous cyclic peritoneal dialysis delivers a prescribed volume overnight. There is an option to fill the patient with a volume to dwell during the day. This is called the last fill option. If enhanced dialysis is required or a patient absorbs a significant amount of fluid during the day, orders may be written to perform one or two additional bag exchanges during the day. The extra exchanges can be done either with twin bags (ie. CAPD bags) or as extra fills using the cyclor machine.

Patients who do not tolerate the day dwell because of back pain, hernia or increased absorption may be on a dry day; however, this reduces the adequacy of dialysis delivered.

#### Sample prescription

Night: 15 litres over 10 hours with 2.5 litre exchange volume, no additives,

Day: last fill option of 2 litres

Total volume = 17L

target weight 58 kg (full with 2 litres)

For diabetics, order frequency of capillary blood glucose monitoring. For patients initiating CCPD for the first time, monitoring should be done 5 x daily (recommended at 0800, 1200, 1800, 2200 and 0200). Patients on long term CCPD require less frequent monitoring unless glycemic control requires manipulation. Diabetics on CCPD

generally receive oral hypoglycemics or if insulin-requiring, two doses of insulin, one pre- dialysis and one post. (see insulin section at the end of this handout)

### Flushes

Flushes must be ordered 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. Use room temperature dialysate (ie not heated)

Flushes are also required for management of peritonitis, or if patient is bleeding into the peritoneal cavity.

## Peritonitis Guidelines

Bacterial peritonitis requires two of the following three criteria to be fulfilled.

1. Abdominal pain
2. Cloudy bags (or WBC count > 100 with mostly leukocytes)
3. Positive cultures

If these criteria are not met, and a patient is well, it is usually not a good idea to start antibiotics.

## Initial Assessment

1. Clinical examination with particular attention to assessment of:
  - abdomen for s/s of peritoneal inflammation (eg. rebound)
  - peritoneal catheter exit site; send swab for C&S if drainage present.
2. Order first dialysate bag to be sent for gram stain, C&S and cell count with differential. If patient is dry or on cycler, try to allow a dwell of 2 – 4 hours in order to get a meaningful sample. If the patient is too ill, a one hour dwell will suffice.
3. Order flush with 1.5% dialysis solution x 3 exchanges, no dwell time, no antibiotics.

For flush, use volume normally used for patient's routine exchanges. Adjust volume only if unable to tolerate due to abdominal pain.

4. Order antibiotics as above
5. Order dialysis prescription, including target weight.  
CAPD per patient routine  
daily antibiotic to be given in 6 hour dwell (4 hour dwell minimum)

Cycler patients should have antibiotics added to the longest dwell. For a cycler patient who normally does only short nocturnal cycles with no day exchange, you can add a long day exchange on top of the usual nocturnal prescription. Alternatively, It may be best to convert cycler ("Homechoice") patients to CAPD with following exceptions:

- continue APD for patients with high transporter characteristics, herniae, or low back pain that do not tolerate CAPD. (daily antibiotic to be given in 6 hour day dwell).

6. Order additional intraperitoneal additives:  
 heparin 1000 units/litre until effluent clears, then 500 u/L prn if fibrin is still present  
 xylocaine 2%, 5cc/L prn for abdominal pain  
 individual requirements for KCl, insulin.
7. Order frequency for effluent sampling for inpatients
8. For patients with residual renal function who are receiving vancomycin, do vancomycin levels at 72 hours post-initial dose.
9. Hold phosphate binders or calcium supplements if peritonitis is severe (due to constipation). Order appropriate diet and all other medications.
10. Patients on peritoneal dialysis who present with peritonitis are managed as outpatients unless severity indicates hospital admission. Admission is also required for patients unable to manage at home.

Bloodwork on admission - CBC and differential, electrolytes, creatinine, urea, calcium, phosphate, protein, albumin.

**11. C&S q2days until first “no growth”; then q4days until total of 3 “no growths”**

Problems To Anticipate  
 (list not comprehensive)

1. If no decrease in cell counts in 3 to 4 days or if count fell initially and then increased, repeat culture and consider

Secondary Peritonitis

- . ischemic bowel
- . cholecystitis
- . diverticulitis
- . appendicitis
- . pancreatitis

## Management Options

- Temporary discontinuation of peritoneal dialysis
- Conversion to cyclical peritoneal dialysis  
may be used for patients with bowel leak; sepsis
- Catheter removal

## 2. Ultrafiltration failure with peritonitis

- . observe for weight gain/ECFV overload
- . alter regimen (ie., shorten dwells, hypertonic bags, more frequent exchanges, query use of cyclical peritoneal dialysis)

## **SMH Peritonitis Protocol 4/2000 Version**

### **Initial antibiotic therapy:**

#### **Patients with < 100 ml 24h urine:**

started on (50 mg for bw > 60 kg , 30 mg for bw < 60 kg) gentamycin and 1 gram cefazolin once daily with an ideal dwell time of 6 hours (at least 3-4 hours).

#### **Patients with > 100 ml 24h urine:**

start on 1500 mg ceftazidime and 1.5 gram cefazolin( ANCEF) once daily with an ideal dwell time of 6 hours (at least 3-4 hours).

Patients sensitive to Ancef: Replace Ancef with Clindamycin 150 mg/L each exchange for at least 14 days. (N.B. no loading dose needed, max 300 mg/bag)

### **Depending on C&S, adjust antibiotics:**

#### **Gram Positives:**

**S. aureus:** Ancef IP x 28 days and rifampin 300 mg BID PO x 21 days  
If MRSA then vanco or clinda

**S. epidermidis:** Ancef IPx 14 days

## **Bowel organisms:**

**Enterococci:** Ampicillin IP 125 mg/L x 21 days, if necessary add aminoglycoside. If resistant to ampicillin, use vancomycin

**Single gram negative:** ceftazidime IP if > 100 ml, or aminoglycoside IP x 14 days

**Enteric:** metronidazole 500 mg q8h IV, PO, PR and ancef IP and ceftazidime IP x 21 days, and consider catheter removal

**Fungal:** fluconazole 200 mg IP q 2nd day and flucytosine LD 2000 mg PO, MD 1000 mg PO

OR amphotericin 25 mg/day IV and flucytosine

OR itraconazole 100 mg PO q12h

Must treat for 4 - 6 weeks or more commonly we must remove the catheter.

If catheter out - fluconazole 200 mg IV or PO post HD x 1 week

OR itraconazole 100 mg PO q12h x 1 week

**Pseudomonas:** continue IP ceftazidime x 28 days and a second antipseudomonal antibiotic

If < 100 ml urine then IP aminoglycoside

If > 100 ml urine then cipro 500mg PO BID or Pip or sulpha/trimet or aztreonam

**Vancomycin** use is discouraged because of concerns about vancomycin resistant enterococci (VRE). If you need to use vancomycin: Vancomycin: 2 gm IP if weight > 40 Kg, 1 Gm if less than 40 Kg, dose q5-7 days

## **Discharge Planning and Follow Up**

Stable patients may be discharged and continue peritonitis therapy at home. Home dialysis unit should be consulted to assess patient's ability to manage medication administration and/or homecare requirements. Patients may require technique review.

If home care is required, please complete the appropriate form in detail. Include dialysis order, antibiotic order, goal weight, heparin order, xylocaine order.

Give patient prescription for antibiotics, heparin, xylocaine if needed. The patient may need syringes and a sharps container.

IP antibiotic prescriptions must be filled at the SM Hospital pharmacy. Follow up will be continued by the Home Peritoneal Dialysis Unit (5794).

If patient is sent home, send a note to HPDU. If admitted, make sure the discharge summary gets to HPDU.

#### Wet Contamination

This is a contamination occurring when the tubing system is open or unclamped, with a potential pathway for organisms to enter the peritoneal cavity.

Order Ancef 1 gm. IP for a 6 hour dwell x 1 dose.

If sensitive to Penicillin/Cefuroxime, order Clindamycin 300 mg IP for 6 hour dwell x 1 dose.

#### Antibiotic Prophylaxis for CAPD Patients

For colonoscopy:

If urine output less than 100 ml/day: 30 mg for bw < 60 kg, 50 mg if > 60 Kg gentamycin and 15 mg/kg (1gram) cefazolin prior to procedure with a dwell time of at least 3-4 hours.

Patients with > 100 ml 24h urine should start on 1500 mg ceftazidime and 20 mg/kg (1.5 gr) cefazolin once daily with a dwell time of at least 3-4 hours.

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

Drain dialysate immediately pre procedure

For dental procedures: follow general guidelines for bacterial endocarditis.

## **PERITONEAL CATHETER INSERTION**

There are standing orders at the nurses station or in HPDU

### **Short Term Management**

Sterile PD dressing to cover exit site and catheter until site heals (about 2 weeks)

### **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 (aqueous hibitaine) and a dry dressing . Twice weekly is the minimum frequency; exit site care should be increased for drainage or infected sites.

For patients with an exit site infection, hydrogen peroxide may be added to the regimen. Me-salt/antibiotic ointments may also be used. In the event of recurrent infections, peritoneal catheters may require removal and replacement.

### **Post- Op Catheter Complications**

An approach is incorporated into standing doctors orders for PD catheters. If these are not in this house staff manual, it is available at the nursing station or in HPDU.

#### **Peritoneal Dialysis Solutions**

PD solutions are available in 4 glucose strengths: 0.5%, 1.5%, 2.5% and 4.25%, representing increasing osmolality with the increases in concentration.

Solutions are also available in standard (3.25 meq/L) and low calcium concentrations (2.5 meq/L). Specify in orders if the low calcium concentration is required.

PD solutions are available in a variety of volumes, from 1 - 3L .

1% amino acid (nutrineal) solutions are available for patients with malnutrition. One exchange is ordered daily. Icodextrin is a new solution with a glucose polymer replacing glucose as the osmotically active agent. It is useful in ultrafiltration failure. It replaces the long dwell. Please get this approved by Dr. Mendelssohn.

## 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

### Maxeran

Used for diabetic gastropathy as an alternative if oral route not beneficial.

Dose: 5 mg/litre for control of nausea

### Potassium Chloride

Used for patients on manual dialysis with frequent exchanges

(ie; in ICU) or on automated systems, especially if predialysis K less than 3.0 mEq/litre or if dialysis is to be prolonged. Patients requiring CAPD alternating with IPD may require intraperitoneal KCl.

Intraperitoneal KCl is not usually added for CAPD but may be considered as an additive if alternatives such as increased dietary intake or oral potassium supplements not possible. Intraperitoneal KCl is used for inpatients on CAPD but is avoided in the outpatient to reduced additional source of technique breaks.

Dose: 2 - 4 mEq/litre (max. dose 10 mEq/L)

### Sodium Bicarbonate

For abdominal pain or cramps felt to be related to pH of dialysate.

CAPD Dose:  $\text{NaHCO}_3$  4.45 mEq/L

IPD Dose:  $\text{NaHCO}_3$  8.9% (1 mEq/L) 10 ml/L (maximum 20 ml/L)

Xylocaine without Epinephrine

For abdominal cramps or pain only after investigations support that the pain is related to dialysate solution. (ie. avoid risk of masking pain related to other causes)

Dose: 1.25 - 5.0 mL/ of 1% or 2% xylocaine without epinephrine

.....

## **Insulin Therapy in CAPD**

One advantage of CAPD is that the patient with diabetes may receive insulin intraperitoneally. This is assessed on an individual basis according to the ability to regulate baseline and sliding scale insulin. Different approaches are used and the following is meant as a guideline only for converting from subcutaneous insulin to intraperitoneal insulin.

**Only short-acting insulin is used for intraperitoneal administration** (ie. Humulin R;Novolin R)

Target blood sugar is 8 to 14 mmol/litre.

To switch from subcutaneous insulin to the IP route:

Calculate the total dose of subcutaneous insulin that is required to control the blood sugar satisfactorily. Double the dose (to account for 50% IP absorption) and divide into 4 doses to be added to the dialysate bags. The night exchange should have 20-30% less insulin than the daytime exchanges.

Insulin must be adjusted per glucose concentration. Increase the calculated amount by 2 units/L for a 2.5% bag and 4 units/L for a 4.25% bag, and decrease by 2 units/L for a 0.5% bag. This calculation will represent the basal dose requirements.

One approach to adjust the insulin is to order the sliding scale, per chart and adjust the requirements based on Capillary Blood Sugars ordered with each exchange. The basal dose should then be adjusted.

### **N.B.**

If peritoneal dialysis is being discontinued, remember to re-assess patients glycemic control and insulin/oral hypoglycemic requirements.

To switch from IP Insulin on CAPD to subcutaneous route

The following recommendations are guidelines only, and must be adjusted to the individual. When CAPD is to be discontinued for a patient on IP insulin, conversion must be made for glycemic control, remembering that a glucose load is no longer delivered by the dialysate.

Calculate the 24 hour requirements for insulin on CAPD. Reduce by 50% . Divide into 2/3 AM and 1/3 PM, then further divide each dose into 2/3 long acting and 1/3 short acting. For patients known to have hypoglycemic episodes, you may consider further reduction in the calculated subcutaneous dose.

Patients who were on dietary control and/or oral hypoglycemics prior to CAPD and converted to intraperitoneal insulin due to the dialysate may return to their pre-CAPD status.

Alternatively, patients may be managed with sliding scale and short-acting insulin to re-establish glycemic control patterns.

#### Insulin Therapy in CCPD

Patients on CCPD generally receive subcutaneous insulin twice daily. If CCPD is discontinued, the pre-cycler dose will require adjustment to account for the discontinuation of the glucose load by the dialysate.

## **Adequacy Tests For Peritoneal Dialysis**

### Peritoneal Equilibration Test (PET)

**DEFINITION:** The PET may be done as a baseline or follow up investigation to determine peritoneal membrane ultrafiltration characteristics. It is **not** a test for adequacy of dialysis.

### Adequest

#### **( 24 HOUR COLLECTION )**

Used to assess adequacy of dialysis and assist in adjusting prescription. **It involves a 24 hour collection of dialysate and urine.**

Write order for “Adequest and 24 hour creatinine clearance”.

Order blood work for day 2 of study including creatinine, urea, glucose, protein and albumin.

### PD Systems and Connectology

#### Automated Peritoneal Dialysis (APD) Systems

These include systems utilizing a cycler machine for dialysis ( Baxter HomeChoice available)

Used for IPD, CCPD, NIPD on In-Patient Nephrology.

#### Continuous Ambulatory Peritoneal Dialysis Systems

There are currently three systems in use for home training and available

**Twin bag** is the most frequently used system. This is a system which attaches to the transfer set and is composed of a fill bag with dialysate and a drain bag. Following exchanges, the transfer set is capped. (the patient is usually weighed in the filled state)

**Ultraset** is similar to the twin bag with the exception that the dialysate bag must be attached with a manual spiking method. This can be used to deliver solutions which are not available in the twin bag set and also

for the administration of amino acid solutions intraperitoneally.  
(the patient is usually weighed in the filled state).

**UV flash** is an assist device used for patients on home dialysis who are not able to manage the twin bag system. The system utilizes a device which performs the spiking step and treats the spike with ultraviolet light.  
(the patient is usually weighed in the drained state)

### Manual Peritoneal Dialysis System

A system utilizing a “Y” set tubing with a drip chamber on the drainage bag. Useful for assessing peritoneal catheters inflow and outflow times. Used in the critical care setting to deliver peritoneal dialysis according to prescription (may be adapted for CAPD and IPD)

The home peritoneal dialysis team hopes this manual is useful. Please feel free to let us know your comments for improvements.

**RESIDENT'S GUIDE TO KIDNEY TRANSPLANTATION AT  
ST. MICHAEL'S HOSPITAL**

**Nick Hariton, PGY1  
Salma Bhaloo, BScPharm**

**Last Update: May 2004**

## **A. PRE-OP PROCEDURES**

### **LIVING-RELATED TRANSPLANT**

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

- 1) Brief history of any recent hospitalization, surgery, illness or blood transfusions that would preclude an elective procedure (eg. recent MI)
- 2) Focused physical exam
- 3) If signs or symptoms of infection (fever, leukocytosis, etc) are present, consider delaying the surgery
- 4) If patient is on dialysis, they should be 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 CCPD, ensure they get their usual dialysis overnight

- 5) Ensure that you have the patient's chart for review from the transplant clinic (61 Queen office x3665). Ensure that you have viral serology for the recipient AND the donor.
- 6) **ORDERS:** Use the ready-made transplant orders for pre-op, post-op, and medications (more on these later). ALL patients require a cross-match. Ensure CXR and ECG are reviewed the evening of admission.
- 7) Consider beta-blockers for patients with medium and high cardiac risk
- 8) TYPE 1 Diabetics will need an insulin drip started in the morning
- 9) Order all regular medications except anti-coagulants

### **CADAVERIC TRANSPLANT**

You will get a call from Trillium Gift Of Life (TGOL) that a kidney has become available for transplant. They will give you the name of the 1<sup>st</sup> (and usually 2<sup>nd</sup>) matched recipient. The recipient(s) will be notified by nephrology resident for urgent admission to hospital and urgent surgery.

- 1) When you get the call, obtain as much information regarding the kidney and donor as possible **DONOR INFO IS CONFIDENTIAL AND SHOULD NOT BE RECORDED IN RECIPIENT CHART** (only document serology in chart for future reference):
  - ◆ age of donor
  - ◆ nature of injury to donor
  - ◆ amount of time on pressors
  - ◆ baseline creatinine and GFR of donor

- ◆ underlying co morbidities (diabetes, hypertension, etc)
  - ◆ anatomy of kidney (# of arteries and veins)
  - ◆ time at which kidney was harvested
  - ◆ blood type of donor
  - ◆ serology of donor (CMV, EBV, HepB, HepC, HIV, HTLV)
- 2) Call urology resident and inform them of a potential transplant
  - 3) Notify 8CC charge nurse of a potential transplant
  - 4) Obtain the SMH transplant list on 8CC and find the recipient
    - ◆ ensure that donor and recipient blood types match
    - ◆ ensure that recipient is not “ON HOLD” for transplant (HD on list)
    - ◆ check to see recipient’s peak PRA and most recent PRA
    - ◆ get recipient’s contact information
  - 5) Call recipient
    - ◆ home phone #
    - ◆ pager (page x3 to 416-864-5097)
    - ◆ dialysis unit (phone # at back of transplant list)
 When speaking to recipient:
    - ◆ introduce yourself and reason for calling
    - ◆ ensure they are ready for transplant (no “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
  - 6) Consider calling in a second recipient if first is highly sensitized (PRA > 75%)
  - 7) Obtain chart from Transplant Clinic. After hours this involves calling security to let you into 61 Queen 9<sup>th</sup> floor and unlock transplant office for you. Photocopier code is 5294A.
  - 8) When recipient arrives perform focused history and physical exam, obtain blood work (including a STAT cross-match), CXR, ECG.
  - 9) If signs or symptoms of infection (fever, leukocytosis, etc) are present, consider canceling surgery and calling in another recipient
  - 10) Assess the need for urgent hemodialysis:
    - ◆ volume overload (clinical exam, CXR)
    - ◆ hyperkalemia (K > 5.0)
  - 11) Cross-match: (HLA lab : 416-340-4995)
    - ◆ ALL recipients will require a cross-match
    - ◆ In the following cases the results of a STAT cross-match must be negative BEFORE beginning surgery:
      - recent blood products
      - current PRA > 20%
      - peak PRA > 50%

- recipient has had prior transplant
  - most recent cross-match > 3 months old
  - no cross match yet done (ie "O" BDR donor from out of region)
- ◆ If cross-match is positive, you must call in another recipient
- 12) ORDERS: Use the ready-made transplant orders for pre-op, post-op, and medications (more on these later)
  - 13) Consider beta-blockers for medium-high cardiac risk
  - 14) Type 1 Diabetics will need an insulin drip
  - 15) Any anticoagulants will have to be reversed (Vitamin K, protamine)
  - 16) Call TGOL (416-363-4438) and let them know who the recipient is

## 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 8-10cm. This can be achieved by replacing urine volume 1:1 with IV replacement. 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	Pending	Pending	Pending	NS 1:1 for U/O
0:30 h	142	90	50	NS 1:1 for U/O
4:00 h	138	50	30	1/2NS 1:1 for U/O
8:00 h	134	50	30	NS 1:1 for U/O

Note:	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<sup>+</sup> should never be considered
- 6) At 24h the IV fluid replacement can be reduced to 1/2 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**

### **IMMUNOSUPPRESSIVE REGIMEN**

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

1. If there is an ongoing study, call Research Coordinator (Michelle Nash –pager 685-9775) to assess patient suitability and obtain consent; they will order immunosuppressives if patient is enrolled
2. Standard regimen is steroids, tacrolimus, and MMF
3. Steroid dosing
  - Methylprednisolone (Solumedrol)
    - 2mg/kg IV on-call to OR
    - then 1mg/kg IV q12h x 48h
  - Prednisone
    - 1mg/kg q24h POD#3-7
    - then 0.5mg/kg q24h POD#8-14
    - then 20mg q24h until transplant clinic follow-up
4. Tacrolimus dosing
  - Tacrolimus (Prograf, FK506) 0.075mg/kg q12h starting evening of OR or POD#1
  - Trough levels daily starting POD#2
  - If diltiazem is used the tacrolimus dose is decreased to 0.05mg/kg q12h
5. Cyclosporine dosing
  - Substitute for tacrolimus in patients who are either intolerant of the drug or at high risk of developing diabetes
  - Cyclosporine (Neoral) 5mg/kg q12h starting evening of OR or POD#1

- C2 levels daily starting POD#2
- If diltiazem is used the cyclosporine dose is decreased to 3mg/kg q12h

#### 6. MMF dosing

- Mycophenolate Mofetil (Cellcept, MMF) 500mg q6h starting evening of OR or POD#1
- If well tolerated may change dose to 1g q12h
- 

#### 7. sirolimus, may be considered as an alternate to MMF

-dosing 2-6 mg /dy,

#### 8. Simulect (basiliximab) may be considered as a steroid sparing agent or if transplant is at high risk of delayed graft function.

#### Steroid sparing:

- family Hx of diabetes
- obesity (BMI > 30)
- known diabetic not on insulin
- known osteoporosis

#### Delayed graft function:

- cold ischemic time > 24h
- donor age > 50
- established delayed graft function post-transplant

Simulect 20mg IV x1 to OR and x1 on POD#4, may choose to give methylprednisolone IV x 48h as well.

In established DGF, simulect may be given and the dose of tacrolimus/cyclosporine decreased

### **HIGH-RISK TRANSPLANT**

- current PRA > 30%
- peak PRA > 50%
- prior transplant

These patients are treated with lymphocyte depleting agents (thymoglobulin) in addition to the above regimen.

1. Start thymoglobulin immediately (< 6h) post-op
2. Dose is 1.5mg/kg to run via central line over 8 hours
3. IV gancyclovir must be given at maintenance doses based on estimated renal function in CMV +ve transplants.

4. Premedication prior to dose to prevent febrile reaction:
  - Diphenhydramine 50mg IV
  - Tylenol 650mg PO/PR
  - These can be discontinued if no reaction after 2 doses
5. Cell counts should be monitored daily during thymoglobulin treatment.
  - target abs lymphocyte count <0.2
  - excessive drop in WBC or PLT requires decreasing or holding thymoglobulin dose
6. Duration of thymoglobulin depends on graft function, usually 5-7 days.
7. Ensure thymoglobulin and gancyclovir orders are given to pharmacy by 12:00 each day

**ANTIMICROBIAL PROPHYLAXIS**

1. All recipients receive intra-op antibiotics  
Cefazolin 1g IV or Clindamycin 600mg IV if penicillin allergic
2. All recipients receive TMP-SMX (Septra SS daily) for PCP prophylaxis for 1 year.  
If sulpha allergy use dapsone 100mg daily.
3. CMV prophylaxis:

Recipient	Donor	Low-risk	High-risk with thymoglobulin
+	+	None	Gancyclovir IV
+	-	None	Gancyclovir IV
-	+	Valgancyclovir PO	Gancyclovir IV
-	-	None	None

- Start valgancyclovir POD#3, dose based on estimated renal function, and continue for 3 months
4. Tuberculosis
    - all transplant recipients should have had a TB skin test
    - TB +ve tests should have received treatment with isoniazid because of high recurrence risk with immunosuppression
    - if currently receiving INH, it should continue after transplant

**OTHER POST-TRANSPLANT MEDICATIONS**

5. Pre-op meds should be reassessed after transplant
  - most medications should be resumed POD#1

- NSAIDs, ACE inhibitors, and ARBs should be held until transplant has normal GFR
  - renal meds (phosphate binders, calcitriol, erythropoietin) can be discontinued
6. Diltiazem is the drug of choice for hypertension; remember to adjust cyclosporine/tacrolimus doses when starting
  7. Iron supplements are usually added for 3-6 months post-transplant

## **THERAPEUTIC DRUG MONITORING**

Appropriate immunosuppression levels depend on time since transplant, with less required as time elapses.

Tacrolimus trough levels (sample immediately prior to dose):

Time from transplant	Target (ng/mL)
0-14 days	10-15
14-30 days	8-15
30-90 days	8-12
> 90 days	5-10

Cyclosporine trough levels (sample immediately prior to dose):

Time from transplant	Target (ng/mL)
0-1 months	350-450
1-3 months	300-350
3-6 months	250-300
6-12 months	200-250
> 12 months	100-200

Cyclosporine C2 levels (sample immediately 2h post morning dose)

Time from transplant	Target (ng/mL)
0-30 days	1500-2000

30-60 days	1300-1700
2-3 months	1100-1500
3-6 months	900-1300
6-12 months	800-1000
> 12 months	600-900

## **D. DELAYED GRAFT FUNCTION**

### Common causes:

#### Prerenal:

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

#### Renal:

- post-ischemic ATN
- hyperacute or accelerated rejection

#### Postrenal:

- ureteric stricture
- lmyphocele or urinoma
- hematoma

### Investigations:

- assess volume status
- check tacrolimus or cyclosporine levels
- check pre-op cross-match
- obtain transplant ultrasound with dopplers and resistive 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 ATN

- prolonged cold-ischemia time ( >24h )
- prior sensitization in a prior transplant
- increased donor age
- 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)
    - o hydrocortisone 100mg IV q8h
    - o 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)
    - o 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 TRANSPLANT PATIENTS**

Common causes Weeks 1-12:

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

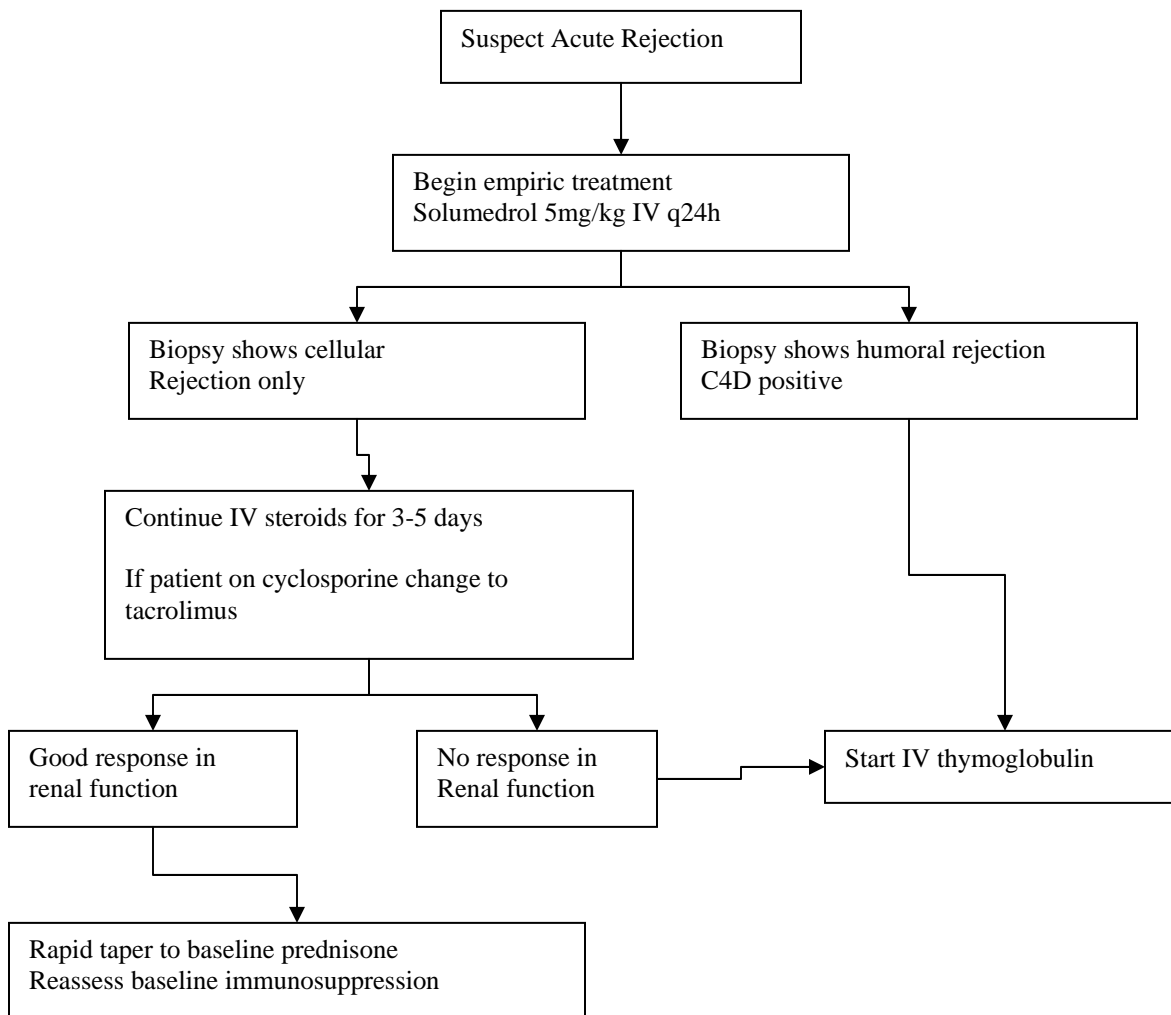
Common causes at > 3 months:

- 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
  - 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

## RENAL FUNCTION

### Kidneys:

- 1) filter, remove wastes
- 2) maintain salt & water balance
- 3) phosphate & calcium balance
- 4) maintain N Hgb ( EPO)
- 5) control blood pressure
- 6) maintain Acid/ base balance
- 7) regulate all major cations/ anions

- simplest estimate of GFR is Plasma creatinine (Pcr)
- PCr is directly proportional to muscle mass and indirectly related to GFR
- Pcr is filtered but also secreted by renal tubules, particularly when GFR falls.  
Therefore at low levels of GFR, Pcr and Clearance of Cr over-estimate true GFR.
  
- REMEMBER look at your patient when using Pcr to estimate GFR
- N GFR 100-140 ml/ min

An 80 yo women who weighs 40 KG has an estimated GFR of only 30 ml/ min with a “normal” Pcr of 80 umol/l

Where as a 20 year old 100 kg man has a GFR of 120 ml/min with a PCr of 120 umol/l

**CrCl in ml/min= (140-age) x LBW/ PCr (multiply x 1.2 for male)**

**Divide by 60 for CrCl in ml/sec**

**CrCl : creatinine clearance**

**LBW: lean body weight in Kg**

**PCr : plasma creatinine**

## ACUTE RENAL FAILURE

**A decrease in baseline GFR occurring over days to weeks with a potential for reversibility**

### A) PRE-RENAL

Decrease Effective Circulating Volume ( ECFV ↓ ) ie “what the kidneys see”

- 8) Volume loss: renal, GI, blood, skin, third space sequestration
- 9) Edematous states : CHF, cirrhosis, nephrotic syndrome
- 10) Renal ischemia: hepato-renal, NSAIDS, bilateral RAS, ACEi , ARB

**Urine lytes :** UNa < 20 meq/l, UCl < 20 ( unless recent diuretic)  
**FeNa = 100 x[UNa] [Pcr ]/[PNa] [Ucr]**  
**FeNa; pre renal < 1, ATN >1**

**U/A: bland**

### B) POST-RENAL

“ The presence of urine does not exclude obstruction “

#### Anatomical

Prostatic hypertrophy  
Cervical Ca  
Strictures  
stones  
External compression; colon ca, lymphoma  
Hematoma, papillary necrosis,  
Retroperitoneal fibrosis

#### Functional

DM  
anticholinergic meds  
neurogenic bladder

Most readily diagnosed by ultrasound demonstrating hydronephrosis

**U/A: bland**

## **C) RENAL**

### **Pre-Glomerular**

- Malignant hypertension
- Scleroderma renal crisis
- Cholesterol emboli
- thrombotic micangiopathy

**U/A: most often bland, sometimes protienuric, occasionally, RBCs, eosins**

### **Tubular**

- ATN (long list: MOST COMMON): shock, sepsis, drugs ( AG antibiotics), contrast, Rhabdo, NSAIDs,

**U/A: heme granular casts, tubular cells, RBCs, crystals**

### **Interstitial**

- Idiopathic
- Drugs; antibiotics, NSAIDs, diuretics, CNI
- Infections
- Infiltration, leukemia, lymphoma
- Radiation
- renal transplant : rejection CNI, polyoma, pyelonephritis

**U/A: casts, WBC, WBC casts, eosinophiluria**

### **Glomerular**

**See GN**

**ARF usually seen in context of RPGN; U/A : RBCs & RBC casts,**

## Classification of the Glomerular Diseases

### **A. Proliferative (a.k.a., “Nephritic”):= ACTIVE URINARY SEDIMENT, RBCs, OR RBC CASTS**

Characterized by hypertension, edema, hematuria, RBC casts, and mild-moderate proteinuria.

1. Mesangial Proliferative: Most common GN, microscopic hematuria, gross hematuria with URI, rarely nephrotic, rarely crescentic (RPGN)

- IgA Nephropathy ( seen in IBD, celiac, arthritis, genetic causes)
- Henoch-Schonlein Purpura (systemic)

2. Endothelial Proliferative (Post-Infectious Glomerulonephritis):

- Post streptococcal GN (PSGN)
- Subacute bacterial endocarditis (SBE)
- Ventriculo-peritoneal shunts
- Visceral abscesses (pulmonary, intra-abdominal)

3. Crescentic, Epithelial Proliferative (Rapidly Progressive Glomerulonephritis):  
NEED TO ESTABLISH DIAGNOSIS, SINCE THESE CAN BE LIFE THREATENING

- Type 1: Anti-GBM GN
  - I) Renal (Anti-GBM Disease)
  - II) Pulmonary-Renal (Goodpasture’s Syndrome)
- Type 2: Immune Complex GN
  - I) Primary (MPGN)
  - II) Secondary (SLE, PSGN, IgA, cryoglobulins)

- Type 3: Pauci-immune Crescentic GN (ANCA +ve)
  - I ) Idiopathic or Pauci-immune Crescentic GN
  - II ) Wegener's Granulomatosis, Microscopic Polyangiitis,
  - III) Churg-Strauss Syndrome

**B. Non-Proliferative (a.k.a., "Nephrotic"):= BENIGN URINE, FEW or NO RBCs**

Characterized by proteinuria  $> 3.5 \text{ g}/1.73 \text{ m}^2/24 \text{ hours}$ , hypoalbuminemia, edema, hyperlipidemia, lipiduria, and hypercoagulability.

1. Primary (a.k.a., Idiopathic):

- a) Minimal Change Disease (lipoid nephrosis, nil disease, epithelial cell disease) Most common in children
  - Adult form
  - Child form
  - Associations include viral URTI, recent immunizations, hypersensitivity to drugs (e.g., NSAIDS) or bee stings, paraneoplastic (e.g., Hodgkin's Disease)
- b) Focal Segmental Glomerulosclerosis (FSGS)
  - Idiopathic
  - Associations include heroin abuse, HIV, reflux nephropathy, chronic pyelonephritis, massive obesity, solitary kidney (renal ablation or renal agenesis), idiosyncratic reaction to drugs (e.g., NSAIDS), circulating factor, genetic causes
- c) Membranous Glomerulonephritis (MGN)
  - Idiopathic
  - Associations include hepatitis B antigenemia, autoimmune diseases (SLE, DM, MCTD, thyroiditis), cancer, drugs (gold, penicillamine, captopril), malaria, syphilis

d) Membranoproliferative Glomerulonephritis (MPGN)(SOMETIMES CLASSIFIED AS PROLIFERATIVE)

- Type 1 (subendothelial deposits)
- Type 2 (intramembrane deposits, dense deposit disease)
- Associations include SLE, cryoglobulinemia, hepatitis C, other chronic viral and bacterial infections, partial lipodystrophy, sickle cell anemia, complement deficiencies

2. Secondary (associated with systemic diseases):

- DM
- SLE
- Multiple Myeloma
- Amyloidosis

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