

UNIVERSITY OF NORTH CAROLINA KIDNEY CENTER

PEDIATRIC KIDNEY TRANSPLANT CLINICAL GUIDELINES

Adapted from Vanderbilt residency manual for adults (2014) and pediatric protocols from Univ of Illinois (2004) and Stanford. These are general guidelines of who to contact, but certainly defer to primary teams clinical judgement to contact all sub-specialists or additional sub-specialists should that seem prudent clinically as each patient will differ.

PRE-OP ROLES <i>SRF service</i>	Primary Team (places all orders)	Primary Consultant	Pg
Labs/Images	SRF		2
PD cell count/cx and arrange for HD/PD if indicated	PMK		2
Evaluation and clearance for OR	SRF	PMK	2
Consent	SRF		2
Bed requests (pre-op, OR posting, post-op in PICU)	SRF		2
Notify teams of pending admission (PICU fellow, other peds sub-specialists that may be required)	SRF		2
Immunosuppression induction; as documented in last transplant committee meeting	SRF upper level/fellow	Most recent transplant committee documentation (SRF and PMK)	2

POST-OP PICU ROLES <i>PICU service</i>	Primary Team (places all orders)	Primary Consultant (who to call first)	Pg
Transplant renal US with dopplers; must occur within 30 minutes of PICU arrival	SRF from OR		
Immunosuppression medications	SRF upperlevel/fellow	PMK	3
Prophylaxis medications	PICU	PMK	4
BP goals/management	PICU	PMK	5-6
Fluid management/UOP goals	PICU	SRF first 24 hours PMK remainder	5-6
Surgical site/JP drain(s), Foley	PICU	SRF	7
Labs/electrolyte/heme abnormalities	PICU	PMK	8-9
Dialysis if needed	PICU	PMK	
Pain management	PICU	PMK	10
Nutrition/bowel regimen	PICU	SRF	10
Out of bed decision	PICU	SRF	
Anti-coagulation	PICU	SRF	10
Transfer to floor (<i>Typically POD 2</i>)	PICU → PMK	SRF and PMK	

POST-OP FLOOR ROLES <i>PMK service</i>	Primary Team (places all orders)	Primary Consultant (who to call first)	Pg
Immunosuppression medications	Transplant Pharm (by direction of PMK)	PMK	3
Prophylaxis medications	PMK		4
BP/Fluids/UOP goals/management	PMK		5-6
Surgical site/JP drain(s)		SRF	7
Foley		SRF/Peds Urology if involved preop	7
Labs/electrolyte/heme abnormalities	PMK		8-9
Pain management/Nutrition/Bowel regimen/Anticoag	PMK	SRF	10
Discharge	PMK	SRF and Ped Coordinator	12

Contact Information:

SRF = Surgical Transplant Team = search by “SUR TRANSPLANT”

Primary contact: Chief resident (123-7461)

Second call would be Attending: Kidney & Carolina Donor Calls

Additional contact information: Primary transplant pharmacist – Kristen Szempruch (216-4760)

Transplant Coordinator – Erin Fischer (216-0597)

SRF PA – Jennifer Shurney (216-1948)

SRF Dietician – Jodi Mettel (123-0086)

5 West (area where team congregates) – 984-974-1601

PMK = Pediatric Nephrology Team = search by “PED NEPHROLOGY”

Primary contact: fellow on call; if no fellow on call, primary contact is the attending

When patient is on the floor, patient is on the PMK service and also cared for by PMA residents (Ped General PMA team).

Additional contact information: PMK Pharmacist – 123-7141

Pediatric Transplant Coordinator – Lynn McCoy (216-9453)

PMA/PMK Team Coordinator – Jennifer Daniels (216-0367)

PMA intern 123-9914; PMA senior resident 123-9915

6 CH (children’s floor where patients typically located) – 984-974-5101

PICU = PICU team = search by “PED CRITICAL CARE”

Primary contact is PICU fellow (984-974-5488)

Additional contact information: Resident phone – 984-974-5487

Charge Nurse phone – 984-974-5493

PICU Pharmacist – 123-7144

Main PICU number – 984-974-5491

PRE-OP Reference Material:

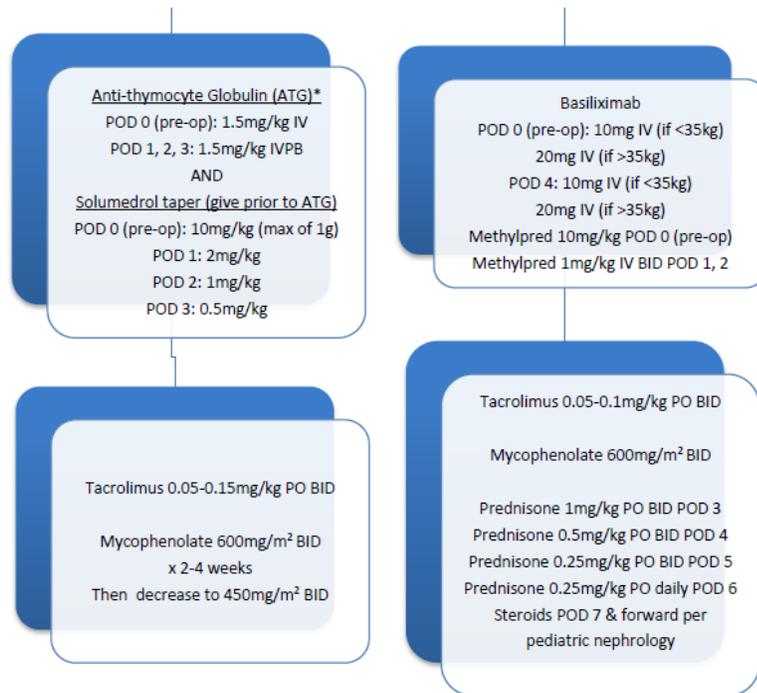
1. On-Call Transplant Coordinator: Notifies SRF attending and PMK attending of potential kidney offer and attendings accept organ. Attendings notify respective teams of organ transplant possibility. PMK notifies recipient of possibility for transplantation with instructions to come to UNC ED. This is always a tentative possibility and not definite until time patient actually goes back to the OR; crossmatch may be positive, someone higher on the list may still get organ, etc.
2. Transplant Surgeons (SRF): evaluate patient, put in orders (chem10, LFTs, CBCd, coags, type and cross match, HLA DSA, CMV IgM/IgG, EBV IgM/IgG, HSV 1/2 IgG/IgM, Hepatitis A/B/C, HIV, CXR, EKG, UA, urine culture, peds nephrology consult), arrange OR time and obtain consent. Orders cefazolin 25mg/kg (max 2gm) for peri-operative antibiotics. Contacts other pediatric subspecialists that may need to be involved (cardiology, hematology, etc) and notifies PICU fellow of potential for patient arrival. Chief resident/Fellow: Orders immunosuppression per last transplant committee meeting documentation. Responsible for notifying patient/family and PMK should patient for some reason not receive the offered kidney as soon as is reasonably possible.
3. Peds Nephrology (PMK): evaluate patient, write H&P note “ok for transplant”, order PD cell count/culture if applicable and notify dialysis RN to send, arranges for dialysis for solute removal if necessary.

IMMEDIATE POST-OP – Immunosuppression Medications

THESE MEDICATIONS ARE ODRED BY SRF team or PMK Fellow/Attending ONLY. Residents or fellows unfamiliar with these medications should not place these orders. Transplant Pharmacy usually available to assist. Guided by last transplant committee meeting and scut monkey

(<https://www.med.unc.edu/transplant/protocols/unc-scut-monkey>).

Keep in mind some children may require tacrolimus dosing TID due to faster metabolic rates. (Ped Neph 2016, Jalanko H, et al)



*Round all thymoglobulin doses to the nearest 25mg

*Thymoglobulin requires pre-medication with methylprednisolone, acetaminophen and diphenhydramine

Thymoglobulin note: CD3 count should be done on POD 4. Do NOT order the thymoglobulin until after SRF attending/fellow on service has confirmed that the patient is to get it that day based on platelets, WBC and infectious parameters. Dosage reductions are recommended for the following: WBC < 2.0, ANC < 1000, Plt < 50 and/or signs and symptoms of infection.

Mycophenolate notes: Conversion based on BSA of two formulations

- cellcept dose x0.6 = myfortic mofetil dosing
- myfortic mofetil dose x5/3 = cellcept dosing

IMMEDIATE POST-OP – Prophylaxis, Isolation

Prophylaxis – defer to PMK and regimen per scut monkey; Primary transplant pharmacist available to assist as well. Typically once taking PO:

- a. Bactrim MWF for PCP ppx x6 months
- b. Nystatin QID for candida ppx. Be sure patient not drinking/eating anything for 30 minutes after taking medicine to allow coating of oropharynx to have maximum effect. x3 months.
 - i. Typically discharged on TID dosing for practical reasons.
- c. Valcyte for CMV ppx, once graft showing signs of functioning, needs to be dose adjusted for eGFR.
 - i. Valganciclovir dose(mg)=7xBSAxCrCl (bedside Schwartz 2009=0.413 x ht(cm)/Screatinine). Max based on adult dosing (900mg daily for high risk; otherwise 450mg daily).
 - ii. Hold if DGF and requiring dialysis. Otherwise will continue x3-6 months.
 - iii. High risk (D+/R-) = 6 months (some often go for 12 months)
 - iv. Intermed/Low risk (D+/R+, D-/R+, D-/R-) = 3 months (some often go for 6 months)
- d. Peri-operative antibiotics = cefazolin 25mg/kg q8h x 3 doses
- e. Famotidine for gut protection while on steroids
- f. SCDs until mobile, unless child < 5yo. SQ heparin only if not OOB by POD 1.
- g. Incentive spirometry q1h for all patients (may need bubbles or pinwheel for smaller children).

Isolation: Patient should be on protective precautions. Patient always needs to wear a mask upon exiting room and should never have more than 2 visitors in the room at one time (exception for healthcare personnel providing care). Nursing needs to be aware of visitor restrictions.

IMMEDIATE POST-OP – Fluids, Urine Output, CVP, Blood Pressure

PICU: In first 24 hours defer to SRF for fluids and UOP parameters, PMK for BP parameters. Afterwards, defer to PMK for fluids, UOP, BP parameters.

Initial orders: Insensibles at 500ml/m²/day with D5NS. UOP+JP output is also replaced 1:1 every 2 hours for first 12-36 hours. Replacement alternates with 1/2NS and NS.

Typically KVO by POD 2 or 3.

	Blood pressure	CVP	Urine Output
Goals	0-2 yrs: SBP 90-120, MAP 60-90 3-10yrs: SBP 100-150, MAP 70-100 >10yrs: SBP 110-160, MAP 70-100 Ped Neph 2016, Jalanko H, et al	10-14	POD 0=100-500ml/hr POD 1=100-400ml/hr POD 2=100-300ml/hr POD 3=100-200ml/hr
Monitoring fluid status	-Assess ins/outs at least q4h while in PICU; q6-8h once on floor -Obtain at least daily weights, may need BID		
Things to consider if low:	-is patient bleeding? Contact SRF immediately. <i>FYI-Urine always bloody post-op but should not have clots.</i> -Is patient intravascularly dry? Try fluid bolus 5-10ml/kg (or 250-500mL). If no response, contact PMK. -is there a cardiac problem? Consider EKG/echo. -Is patient hypocalcemic? Check ical, replete if low. -If answer is no to all of the above, Contact SRF/PMK depending on how far out post-op and may need to consider dopamine to maintain BP. <i>Fyi typically start with dopamine drip of 1-3mcg/kg/min.</i>		
		-is foley patent? Consider flushing with 30ml sterile NS. Contact SRF/PMK if persists for more than 2 hours. May consider bladder scan or RUS. -Is patient fluid overloaded with low UOP? Consider IV Lasix 1mg/kg (up to 50-100mg IV).	
Things to consider if high	-is patient fluid overloaded? Consider IV Lasix 1mg/kg (up to 50-100mg IV depending on GFR). If in PICU can try first dose, but if no response contact PMK. If patient on floor, contact PMK prior to giving diuretics. -was patient on clonidine pre-op? Contact PMK about restarting dose. -is pain well controlled? See pain section and contact PMK re additional meds. -Try PRN labetalol or hydralazine. If does not respond to first dose, contact PMK.		
FYI information	Living Donors: Should never be oliguric – should always have immediate graft function with high UOP and falling creatinine. If not, then rule out treatable causes immediately (bleeding, hypotension, obstruction, etc). If low UOP persists, consider Delayed Graft Function (DGF) which may occur ~3% in living donors, 7.5% in deceased donors in pediatrics (SRTR 2015 Annual Report). DGF is a very significant adverse event in pediatric grafts with short- and long-term repercussions for graft survival. See below. POD 1 patients typically very fluid +, up to 4-6L. By POD 2 and further should be net negative daily so back to dry weight by POD 3-4.		

Hypertension: anti-hypertensives directed by PMK

1. No ACEi or ARBs post-transplant.
2. If patient on ≥ 3 anti-hypertensives pre-transplant, continue at least one post-op unless having hypotension. Typical preference is for Calcium Channel Blocker (to counteract the vasoconstriction in the kidney from calcineurin inhibitors (tacrolimus); nicardipine drip or amlodipine). Caution with nicardipine as it can increase tacrolimus levels, but you are monitoring daily so should be ok if needed. Often will need to go home on 1-2 antihypertensives.
3. Goal is to have BP in 50-95th% for gender/age.
 - a. PRNs: labetalol (0.2-1mg/kg IV, max 40mg; q12h), hydralazine (0.1-0.2mg/kg IV q6h; max 20mg)
 - b. Nicardipine drip can be used if needed.

Access:

1. Venous: typically PIVs sufficient. Preferable to have IJ for 2 days post-op to monitor CVP. May use tunneled vascath for CVP monitoring if present. If no IJ or tunneled vascath, do not need to insert one in PICU if pressures/UOP following typical expected course.
2. AV fistula: if present, must ALWAYS have arm extremity precautions ordered (no IVs, no BPs, no blood draws) and sign above bed, indefinitely.
3. PD catheter or HD tunneled vascath: will need to be coordinated for removal prior to discharge if uncomplicated course

IMMEDIATE POST-OP – Surgical Site, Drains, Foley

PICU: defer to SRF for management/issues

JP Drain: typically remains in until POD 4-5. Typically removed prior to discharge.

-Removal done by SRF (typically when JP output < 50mL/day)

Foley: typically remains in until POD 3-5 if no GU abnormalities.

-Removal done by nursing when ok'd by SRF.

-Peds Urology *needs* to be involved if there were any prior urological surgeries or involvement.

-Ideally foley should be removed in the AM to ensure good UOP after removal later in the day.

IMMEDIATE POST-OP – Imaging, Labs for a typical/uncomplicated course

PICU: generally defer to PMK if abnormalities unless concern for acute bleed then contact SRF

	Timing	Ordering team	Who to notify of results/abnormalities
Transplant RUS with dopplers	Must be done within 30 minutes of arrival	By SRF in OR	SRF and PMK
Chem10	Q8h first 24 hours, then q12h next 24 hours, then daily <i>If child <5yo, get q4h initially</i>	PICU	PMK
CBCd	Daily <i>If child <5yo, get q12h initially</i>	PICU	PMK
Tacrolimus troughs	Daily (starting after 3 rd dose) -must be drawn EXACTLY 12 hours after evening dose, typically 6am	Transplant pharmacist (If unavailable, ordered by: PICU: SRF chief resident Floor: PMK/PMA residents)	PICU: SRF chief resident/fellow Floor: PMK fellow/attending

Abnormalities:

- a. **Hyperkalemia:** Treat as in any patient with AKI, typically only see in DGF.
 - i. Notify PMK immediately if K > 6.
 - ii. Eliminate K from fluids, low K diet
 - iii. Removal: Lasix, PO kayexalate (only if tolerating PO and typically wait at least until POD1), dialysis as last resort. Never give kayexalate enema in renal transplant patients (a/w rectal perforations *S Med J 2009 McGowan CE et al*).
 - iv. Temporary: insulin/glucose, bicarb
- b. **Sodium:** Monitor closely as patients can have large diuresis post-op so may need adjustments in fluids. Notify PMK should serum Na < 130.
- c. **Calcium:** Place on PICU electrolyte replacement protocol. If persistently low and BP low, additional IV calcium can help.
- d. **Phosphorus:** May need phos replacement, POD 2 or 3 but depends on PO intake and preferably orally.
- e. **Magnesium:** Monitor as may need replacement prior to discharge with MagOx as tacrolimus can decrease mag levels.
- f. **Tacro troughs:** Goal level is 8-10. Important that this level is **drawn EXACTLY 12 hours after evening dose** is given (ie PM dose given at 7pm, AM lab MUST BE DRAWN at 7am, even if it comes at shift change for nurses). Typically doses given at 6pm/6am or 8pm/8am to avoid shift change.

- g. Hemoglobin/Anemia:** Notify SRF if concern for blood loss.
- i. Assess for acute blood loss – JP filling > 100ml/hr, rapid increase in JP drain output, dressings soaked with blood, active oozing. It is typical for dressing to be serosanguinous.
 - ii. Acute drop in Hg (>1)/Hct (> 3%) in 12 hours.
 - iii. Avoid transfusions as much as possible, as patient still likely to need future transplant in their lifetime.
 - iv. Typically if Hg < 10 persistently, will need to restart epogen or darbaepoetin per PMK. Continuing home epogen dose or converting to equivalent darbaepoetin dose is typical starting dose; depends on insurance and likelihood of needing chronic therapy.

IMMEDIATE POST-OP – Pain management, Nutrition, Anti-coagulation

1. **Pain management** – per PMK
 - a. scheduled Tylenol and dilaudid (PCA if able to do so)
 - b. avoid morphine due to theoretical risk of accumulating metabolites and causing AKI
 - c. No NSAIDs

2. **Nutrition** – per SRF
 - a. Typically begin clear liquid diet night of transplant and then advance to regular as tolerated by POD 1; no diet restrictions if normal graft function
 - b. If there is concern for DGF (delayed graft function), patient should be on renal diet (low sodium, low potassium, low phosphorus) until renal function returns.
 - c. Schedule Colace and PRN miralax once tolerating clear diet.

3. **Out of Bed** – per SRF. Typically by POD 1.

4. **Anticoagulation:** per SRF
 - a. Children > 10 years of age:
 - i. daily baby aspirin 81mg when ok by SRF team to initiate, typically POD 3-4.
 - b. Children < 10 years of age:
 - i. Some form of aspirin may be considered in younger children, depending on size of graft (adult vs pediatric) because the incidence of renal thrombosis in young children can be as high as 10%, which increases the risk for graft loss. *Ped Neph.* Jalanko H, et al. 2016.
 - ii. Decision made as joint discussion between SRF and PMK attendings.

IMMEDIATE POST-OP – Delayed Graft Function reference material

5. Risk factors: (Perico N, et al; *Lancet* 2004; 364:1814-27)
 - a. high KDPI
 - b. prolonged cold ischemia time (typically if > 18-24 hours) and/or warm ischemia time (typically >30 minutes)
 - i. WIT = Warm Ischemia Time = time when there is no blood flow in organ and it has not been chilled yet; time stops when organ is chilled or it is reperfused in the body
 - ii. CIT = Cold Ischemia Time = time while organ is chilled with cold fluid flushed through organ; if organ preserved on a pump, still considered CIT but prolongs viability of organ
 - c. donor >55 years
 - d. hemodialysis with fluid removal within 24hrs before transplant
 - e. ureteral leakage or obstruction
6. Definition: requirement for dialysis in first week post-transplant
7. Prevention efforts:
 - a. **Good renal perfusion!** (maintain BPs and CVPs within goal and good UOP).
 - b. Can trial high dose Lasix 1-2mg/kg IV up to 100mg IV to promote diuresis, eliminate K+, and reduce need for dialysis.
 - c. Ensure no bleeding or obstruction (make sure foley patent)
 - d. Otherwise treat supportively as in any patient with AKI.
8. If <25% decline in serum creatinine or oligoanuria by POD 3, repeat RUS with Doppler to follow resistive indices and r/o surgical complications/obstruction.
 - a. If elevated resistive indices in main renal vessels → there is concern for thrombosis, obstruction, or other blockage of vessel preventing good flow to/from the kidney.
 - b. If elevated resistive indices in periphery of kidney → this may be due to post-op edema or it may be an indication of developing acute rejection.
 - c. If concern for elevated resistive indices, should discuss with SRF immediately.
 - d. Approximately normal RI values 0.5-0.7 but higher values in patients with BSA < 0.75 are normal. (Pediatr Transplant 2010, Gholami et al).
 - e. If by POD 5 still with oligoanuria or <25% decline in serum creatinine, SRF attending and PMK attending consider renal biopsy to rule out rejection.

DISCHARGE PLANNING:

Goals Prior to Discharge		Performed by:
Access	Removal of PD or vascath, if uncomplicated post-op course	<u>PMA</u> residents coordinate removal
	Removal of foley Removal of JP drains	<u>SRF</u>
FEN	Taking good PO, keeping up with UOP Family knows how to measure/monitor ins/outs and has hat for going home	<u>PMA</u> residents
Meds	(1) Immunosuppression and prophylactic antimicrobials ordered by POD 2 to clear insurance hurdles. Sent to UNC Outpatient Pharmacy unless notified otherwise. (2) Notify Carolina Care @ Home (123-9815, Asha Barnes) that medications sent down to begin processing	<u>SRF PA</u> . (Peds Trans Coord if not available; PMK if neither available)
	(3) All other medications ordered ~POD 4 so meds are in hand by POD 5. (4) Notify Carolina Care @ Home (123-9815, Asha Barnes) that additional medications sent down.	<u>PMK</u> w/ <u>Peds Trans Coord</u> support
	(5) Notify Carolina Care @ Home (123-9815, Asha Barnes) on day of discharge as early as possible to prepare medications to be available for family to have in hand. Typically need about 4-5 hours to prepare medications.	<u>PMK</u> w/ <u>Peds Trans Coord</u> support
	(6) Family teaching (7) Confirm medications in hand (8) Orange card (medication list) in hand and accurate	<u>Transplant Pharmacy</u> (Peds Trans Coord if not available; PMK if neither available)
Urology	Contact Peds Urology about transplant and request pre-op visit consult and consent while inpatient for stent removal	<u>PMK</u>
School	Notify hospital school (Karen Weatherly) for arranging home schooling x6 weeks post-discharge.	<u>Peds Trans Coord</u> (SRF Trans Coord if not available; PMK if neither available)
Home care	(1) Home management, monitoring, precautions education (2) Provide with educational binder and monitoring charts (daily weights, temp, BP, ins/outs) <i>Fyi-typically takes at least 3 days, may be longer.</i>	<u>Peds Trans Coord</u> (SRF Trans Coord if not available; PMK if neither available)
	Education on warning signs to call PMK at home: -BP too high/low -fever -UOP too low -Not keeping up with intake, emesis, diarrhea	<u>PMK/PMA</u> residents
Follow-up	(1) Peds Nephrology- weekly x 6 weeks; then q2 weeks and spaced depending on clinical course, social situation, etc (2) Outpatient labs- 3x/week x6 weeks; then 2x/week, etc. (BMP, Mag, Phos, CBCd, tacrolimus trough) (3) Peds Urology – ureteral stent removal about 4 weeks post-op (4) RUS – 1 week after stent removal and then again 1 month later	<u>Peds Trans Coord</u> (SRF Trans Coord if not available; PMK if neither available)
Discharge	When agreed upon by <u>SRF</u> and <u>PMK</u> and all above are complete – typically POD 5-7.	<u>SRF</u> & <u>PMK</u>

