

Kidney and Pancreas Transplantation: A Clinical Introduction for Advanced Practice Providers

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Disclosures

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Objectives

Background and Significance of Kidney and Pancreas Transplant

Types of Transplant at UCI

Pre-Transplant

Transplant Surgery

Post-Transplant Management

Post-Transplant Complications

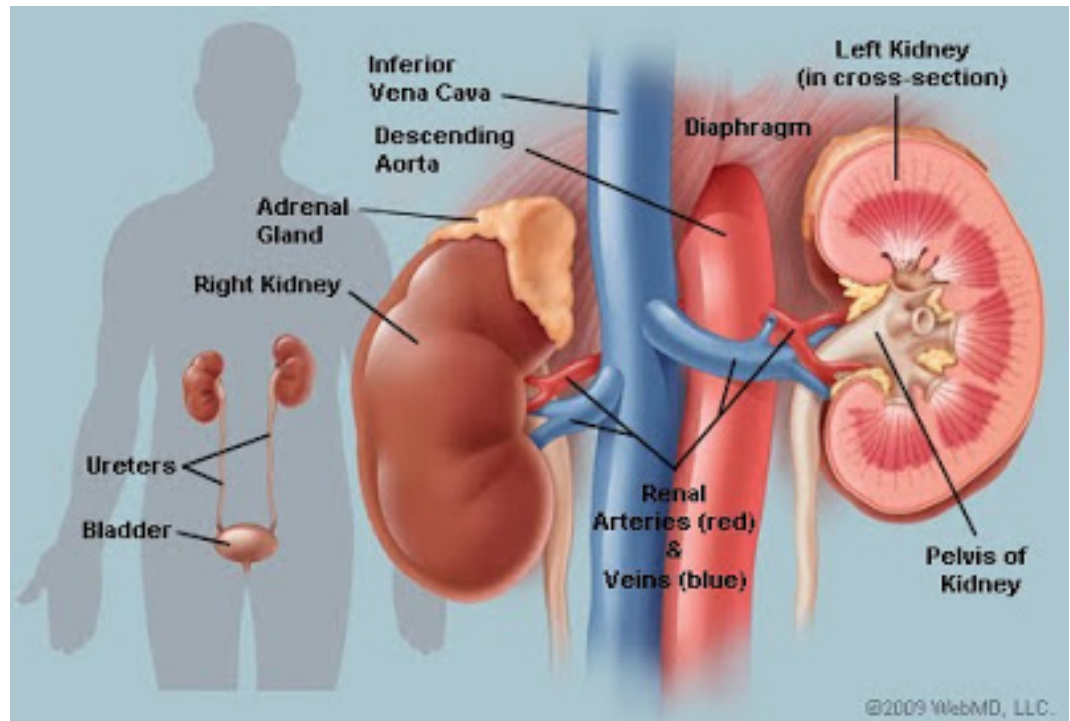
Vaccines

Living Donation

Confidentiality

Background and Significance of Kidney and Pancreas Transplant

- Chronic Kidney Disease (CKD)
 - Any condition that causes reduced kidney function over a period of time
 - May lead to end-stage renal disease (ESRD) → total/permanent renal failure.
 - Stages of CKD
 - Stage 1- GFR ≥ 90
 - Stage 2- GFR 60-89
 - Stage 3- GFR 30-59
 - Stage 4- GFR 15-29
 - Stage 5- GFR < 15



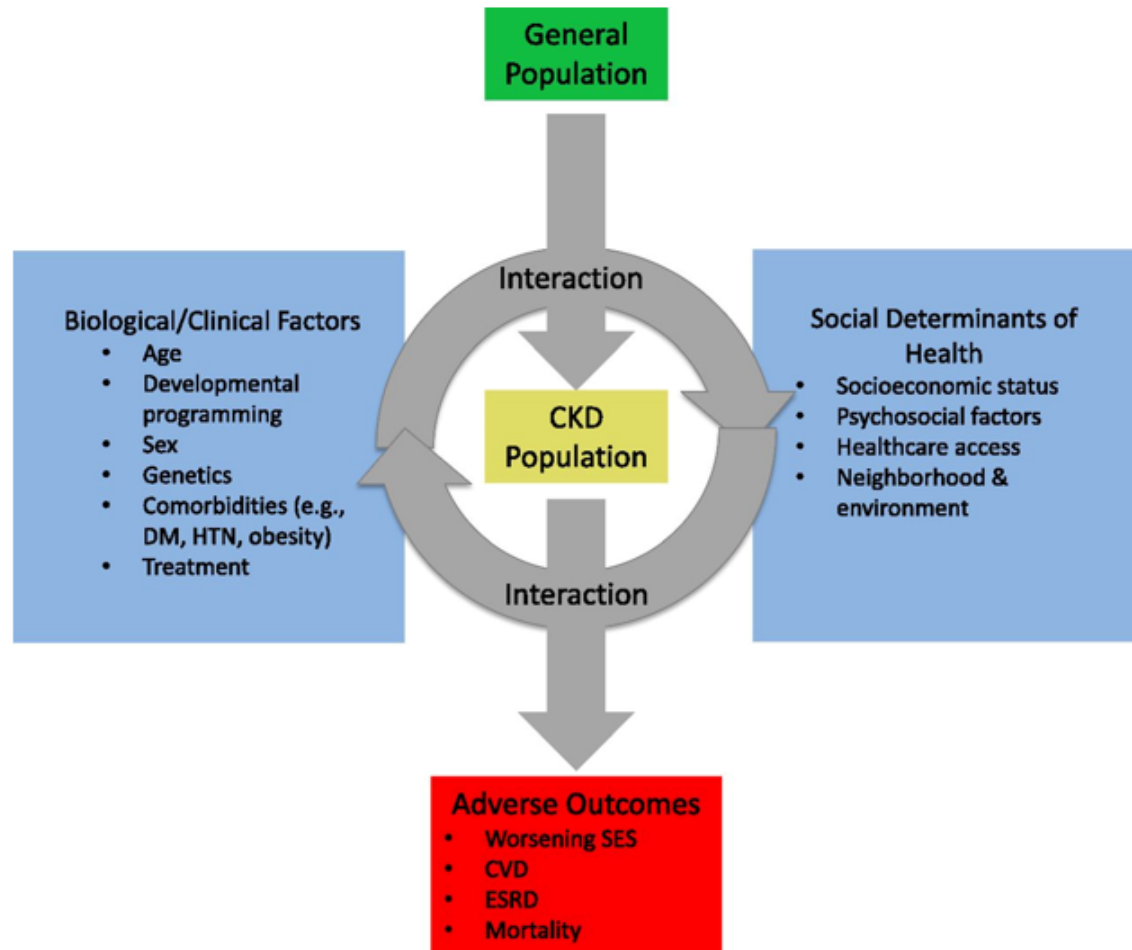
Background and Significance of Kidney and Pancreas Transplant

- CKD

- Overall prevalence ~14% of general population
- **HTN and DM** are leading causes of CKD
- Other causes include: renovascular disease, severe/prolonged AKI, obesity, heart failure, liver failure, autoimmune disease, recurrent/complicated UTIs, reduced kidney mass (ex: nephrectomy, renal agenesis), cystic disease, interstitial disease, glomerulonephropathies, cancer (ex: myeloma or RCC), urinary tract obstruction, nephrotoxic medications, etc.
- Common for CKD pts to have multiple co-morbidities, including DM and cardiovascular disease
- Often no symptoms in early stages (“silent disease”)
- Increased mortality rate
 - In 2013, 47,000+ Americans died from kidney disease

Background and Significance of Kidney and Pancreas Transplant

Theoretical model: interaction of biologic and clinical factors with the social determinants of health affecting CKD risk and progression.



Jenna M. Norton et al. JASN 2016;27:2576-2595

Background and Significance of Kidney and Pancreas Transplant

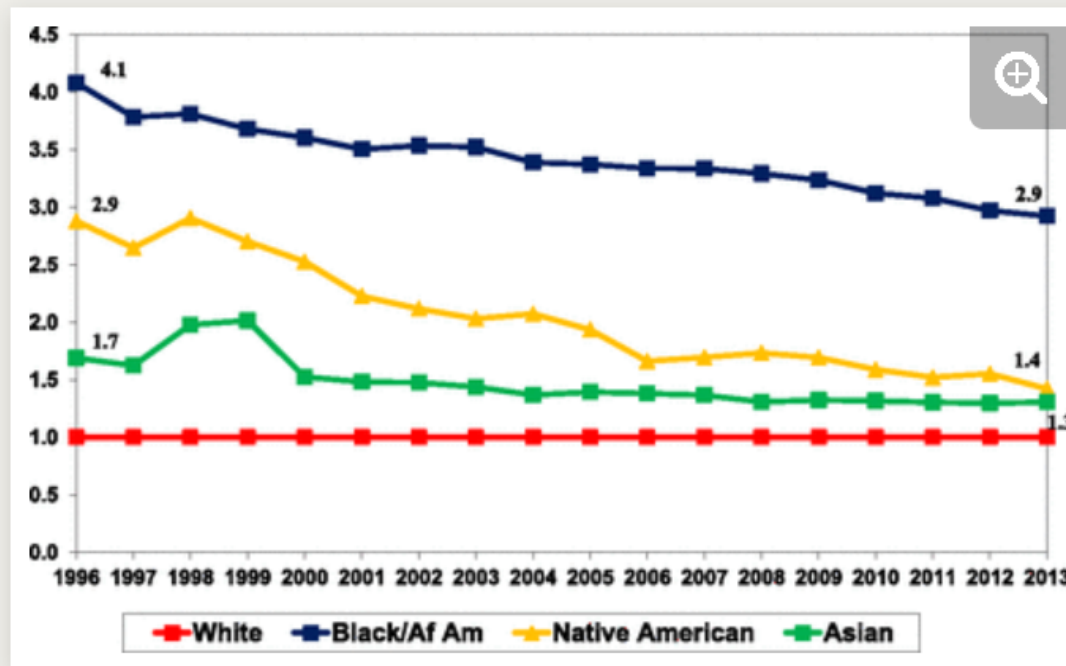


Figure 4.

[Download figure](#) | [Open in new tab](#) | [Download Powerpoint](#)

Trends in adjusted ESRD incidence rate by race in the United States, 1980–2012. Trends in age- and sex-adjusted ESRD incidence rate, per million/year, by race, in the United States population, 1980–2012, with the United States population in 2011 as the standard population. The incidence of ESRD among Native Americans fell dramatically between the late 1990s and 2012. Reprinted from United States Renal Data System. 2014 USRDS annual data report: Epidemiology of kidney disease in the United States. National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD, 2014, with permission. Af Am, African American.

Background and Significance of Kidney and Pancreas Transplant

- Diabetes Mellitus

- 34.2 million people have diabetes (10.5% of US population)—many undiagnosed
- 88 million adults have pre-diabetes (34.5% of adult US population)
- 1.6 million Americans have Type 1 DM (~187,000 children and adolescents)
- 7th leading cause of death in the US in 2017



Background and Significance of Kidney and Pancreas Transplant

Diabetes by race/ethnicity

The rates of diagnosed diabetes in adults by race/ethnic background are:

- 7.5% of non-Hispanic whites
- 9.2% of Asian Americans
- 12.5% of Hispanics
- 11.7% of non-Hispanic blacks
- 14.7% of American Indians/Alaskan Natives

The breakdown among Asian Americans:

- 5.6% of Chinese
- 10.4% of Filipinos
- 12.6% of Asian Indians
- 9.9% of other Asian Americans

The breakdown among Hispanic adults:

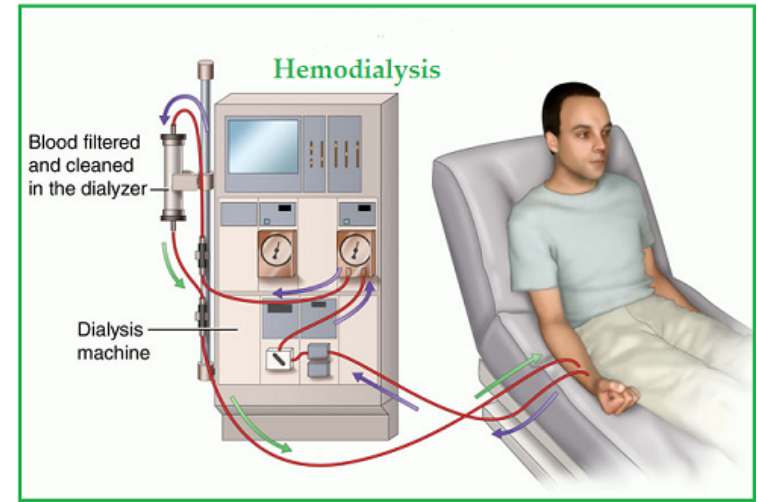
- 8.3% of Central and South Americans
- 6.5% of Cubans
- 14.4% of Mexican Americans
- 12.4% of Puerto Ricans



Background and Significance of Kidney and Pancreas Transplant

- Treatment options for ESRD

- Dialysis
- Renal Transplant



- Treatment options for Diabetes

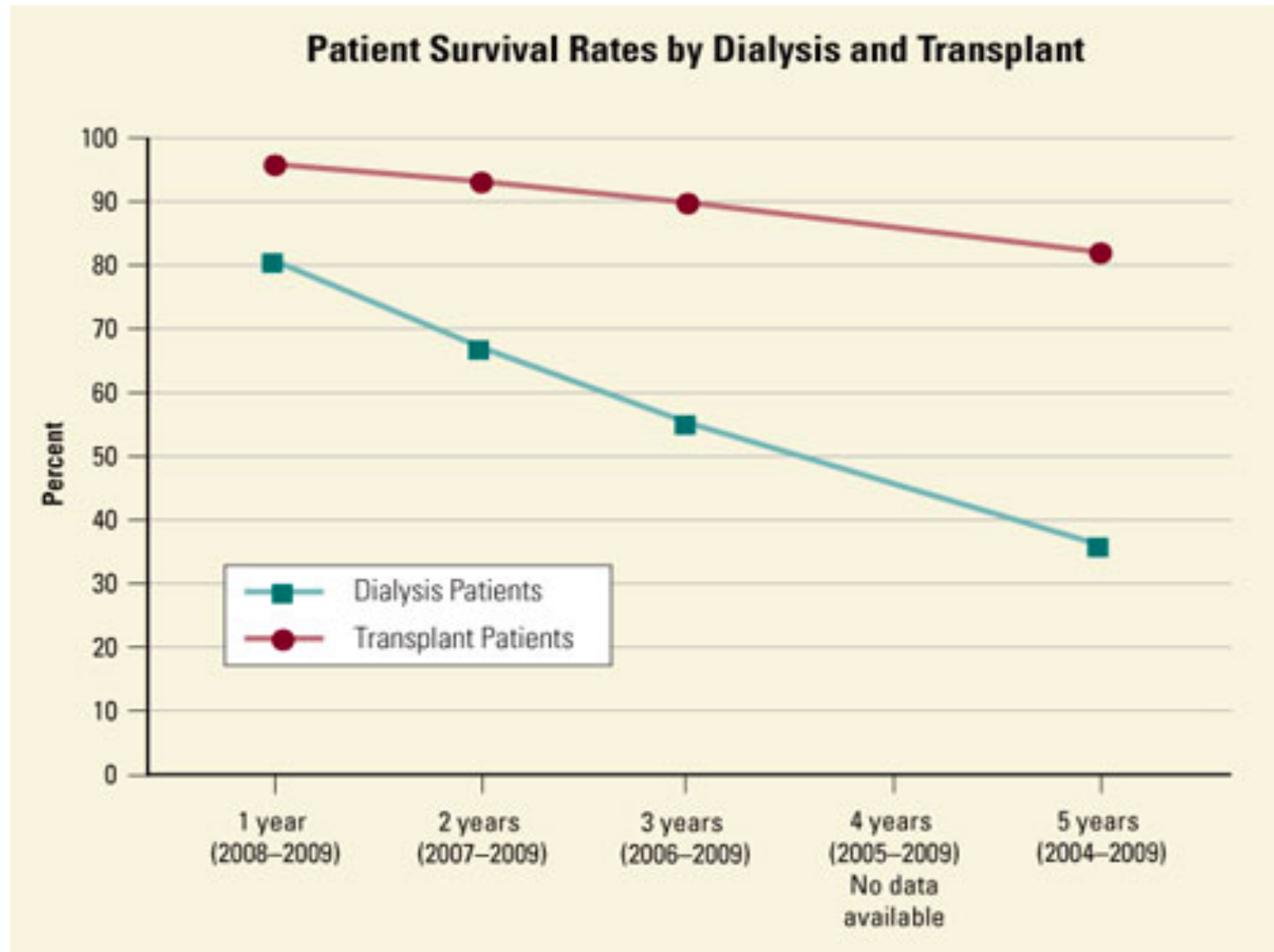
- Medical/lifestyle mgmt
- Pancreas Transplant
- Type 1 DM
- Type 2 DM (*must meet specific criteria)



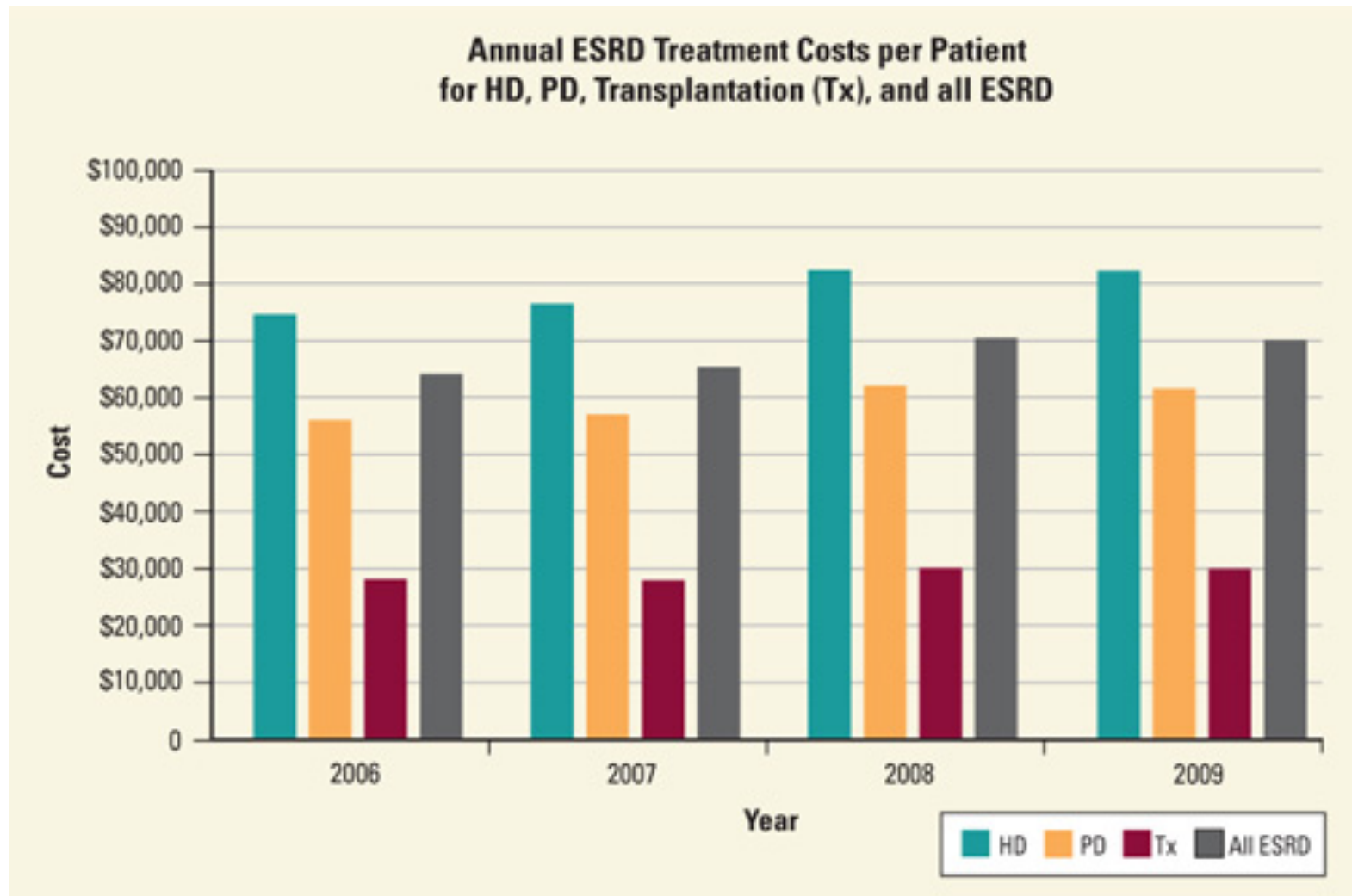
Background and Significance of Kidney and Pancreas Transplant

Dialysis/Medical Management	Transplant
<ul style="list-style-type: none">• Dialysis typically 3x/week (In center or at home)• Reported decrease in QOL• Disrupted work, school, family life/schedules, etc.• Renal diet• Fluid restrictions• Chronic issues such as fatigue, muscle cramps, itchy skin, labile blood pressures, low appetite, access issues (clots, infection), etc.• Travel restrictions• <i>Pancreas: Hypo/Hyperglycemia, Hypoglycemic unawareness, insulin dependent, diabetic neurovascular complications (ex: retinopathy, neuropathy)</i>	<ul style="list-style-type: none">• No longer require dialysis• Reported increase in QOL• Usually able to resume work, school, family activities, etc.• More liberal diet• Encourage fluids• Improved symptoms associated with dialysis (increased energy, improved BP's, increased appetite, etc.)• Few Travel Restrictions• <i>Pancreas: Normalized glycemic control, no longer require insulin, potential slowing of diabetic neurovascular complications (ex: retinopathy, neuropathy)</i>

Background and Significance of Kidney and Pancreas Transplant



Background and Significance of Kidney and Pancreas Transplant



Background and Significance of Kidney and Pancreas Transplant



- Compared to remaining on dialysis patient's undergoing kidney transplantation
 - Live longer
 - Have a better quality of life
 - Save on overall medical costs
- Kidney Transplantation is the optimal therapy for ESRD and certain diabetic patients who can undergo transplantation

Transplant at UCI

- Kidney
- Simultaneous Pancreas and Kidney (SPK)
- Pancreas



Transplant at UCI

- Highly regulated field (CMS, UNOS, OPTN)
- Outcomes

Organ: KI: Kidney		1 Year	AS EXPECTED	1 Year		1 Year
<i>Source Table</i>		UCI		UCI		United States
Post-transplant Outcomes (07/01/2017-12/31/2019)		Observed		Expected	Outcome Assessment	Observed
Adult Graft Survival (based on 257 transplants)(%)	<i>Table C6, pg26</i>	95.22		95.09	As Expected	95.75
Adult Patient Survival (based on 228 transplants)(%)	<i>Table C12, pg44</i>	96.96		97.59	As Expected	97.61

Organ: KP: Kidney-Pancreas		1 Year	AS EXPECTED	1 Year		1 Year
<i>Source Table</i>		UCI		UCI		United States
Post-transplant Outcomes (07/01/2017-12/31/2019)		Observed		Expected	Outcome Assessment	Observed
Adult Kidney Graft survival (based on 13 transplants)(%)	<i>Table C6DKI, pg19</i>	100.00		96.37	As Expected	96.17
Adult Patient Survival (based on 13 transplants)(%)	<i>Table C12D, pg25</i>	100.00		97.13	As Expected	97.69

*** Pancreas graft failure has not yet been defined**

Source: SRTR (Scientific Registry of Transplant Recipients) - Released 1/5/2021

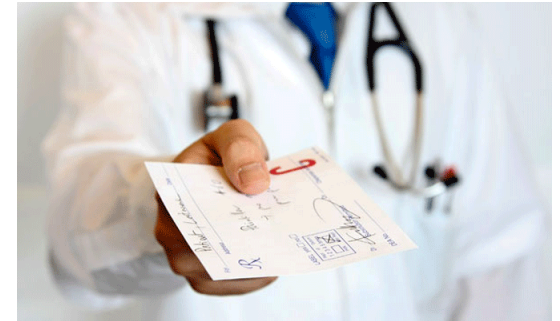
Transplant at UCI

- Interdisciplinary Care
 - Essential to patient/program success
 - Transplant involves:
 - Physicians
 - Advanced Practice Providers
 - Transplant Coordinators/nurses
 - Pharmacists
 - Social Workers
 - Dietitians
 - Financial Coordinators
 - Administrative Assistants
 - Data Analysts
 - Quality Specialist
 - Lab
 - Inpatient Teams (Nursing, case managers, pharmacy, OR, PT, OT, RD, etc.)
 - Specialty Teams (ex: Pathology, ID, Cardiology, IR, Anesthesiology, Endocrine, ER, etc.)
 - Primary Nephrologist
 - Dialysis Team (SW, RD, Nursing, etc.)
 - The patient and their family/support persons



Pre-Transplant

- Referral
 - Provider refers to transplant center for evaluation
 - Usually done through dialysis center/Social Work
 - Early referral is key! Can list patients prior to starting dialysis if GFR <20 (“pre-dialysis”)
 - RN/MD screens referral records for suitability/absolute contraindications
 - Active/recent malignancy
 - Active Infection
 - Uncontrolled psychiatric disorders
 - Lack of social support
 - Substance abuse (including any kind of smoking)
 - Severe or irreversible heart-lung-liver disease (consider dual organ transplant?)
 - Age
 - Some centers have criteria for <70 y/o. UCI will do >70, evaluates on case by case basis.
 - Patient Education Class



Pre-Transplant

- Evaluation
 - Clinical Evaluation
 - MD/NP
 - Surgeon
 - Social Worker
 - Dietician
 - Pharmacist
 - Diagnostics/Consults
 - Labs
 - Cardiac evaluation (EKG, ECHO, Stress, +/- Cath)
 - Abdominal imaging
 - Health maintenance (ex: Colo, pap, mammo)
 - Additional consults prn (ex: Endocrine, Cards, Neuro, Psych, etc.)
 - Financial Evaluation
 - Selection Committee



Pre-Transplant

- Waitlist
 - Managed by UNOS (United Network for Organ Sharing)
 - As of 3/2021:
 - 91,145 candidates waiting for Kidney transplant
 - 989 candidates waiting for Pancreas Transplant
 - 1,706 candidates waiting for Kidney/Pancreas transplant
 - 730+ patients on the waitlist at UCI.
 - Average wait time for a kidney in our area is **6-10 years**

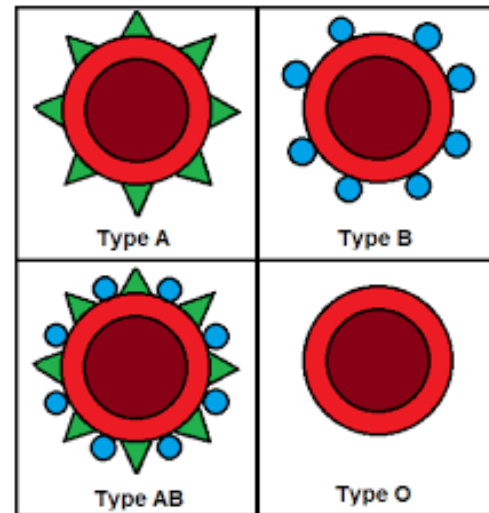
O Blood Group: 10 Years

A Blood Group: 7- 8 years

B Blood Group: 8 -10 years

AB Blood Group: 5 - 6 years

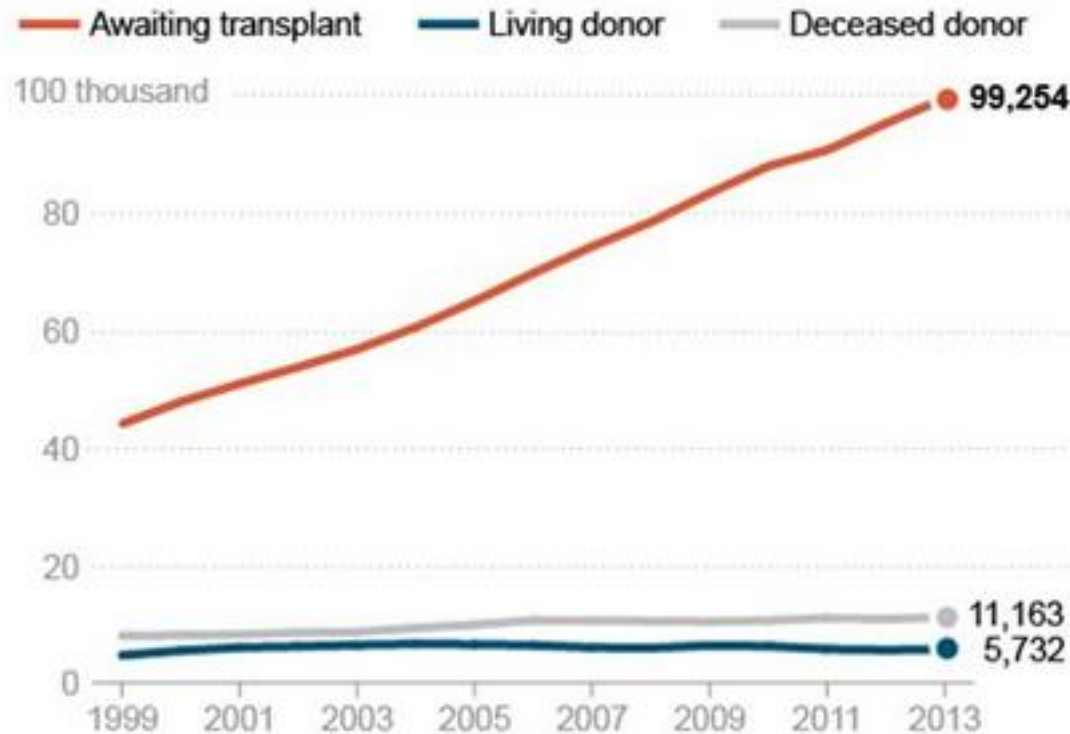
**Approximate local wait times by blood group*



Pre-Transplant

Kidney transplants

The number of patients awaiting kidney transplants has far outpaced available organs from donors.



SOURCE: Organ Procurement and Transplantation Network

AP

Pre-Transplant

- It is important for our patients to stay healthy while on the waitlist so that when an organ offer comes, they are ready.
 - Healthy diet and exercise (Adhere to fluid restrictions and renal diet)
 - Maintain a healthy weight
 - Go to all dialysis and medical appointments
 - Take medications as prescribed
 - Follow the recommendations of the healthcare team
 - NO alcohol, smoking (including marijuana), vaping, or any non-prescription drugs
 - Stay UTD on HCM (vaccinations, pap, mammo, colo, PSA, etc.)
- Continue under the care of their PCP/nephrologist.
- Undergo annual re-evaluation with the transplant team and update testing, labs, consults as indicated.



Transplant Surgery

- Organ Offers
 - Can come any time of day (24/7, 365)
 - Sometimes they move very quickly (must respond within 30 mins), other times it may take days
 - Not all organ offers work out (various reasons—donor or recipient issues)



Transplant Surgery

- Pre-Op
 - H&P
 - Diagnostics
 - Labs, CXR, EKG, etc.
 - Dialysis (prn)
 - Consents
 - Use Special Transplant Consent
 - **NO PICC LINES**
 - Need to preserve vasculature for possible future access

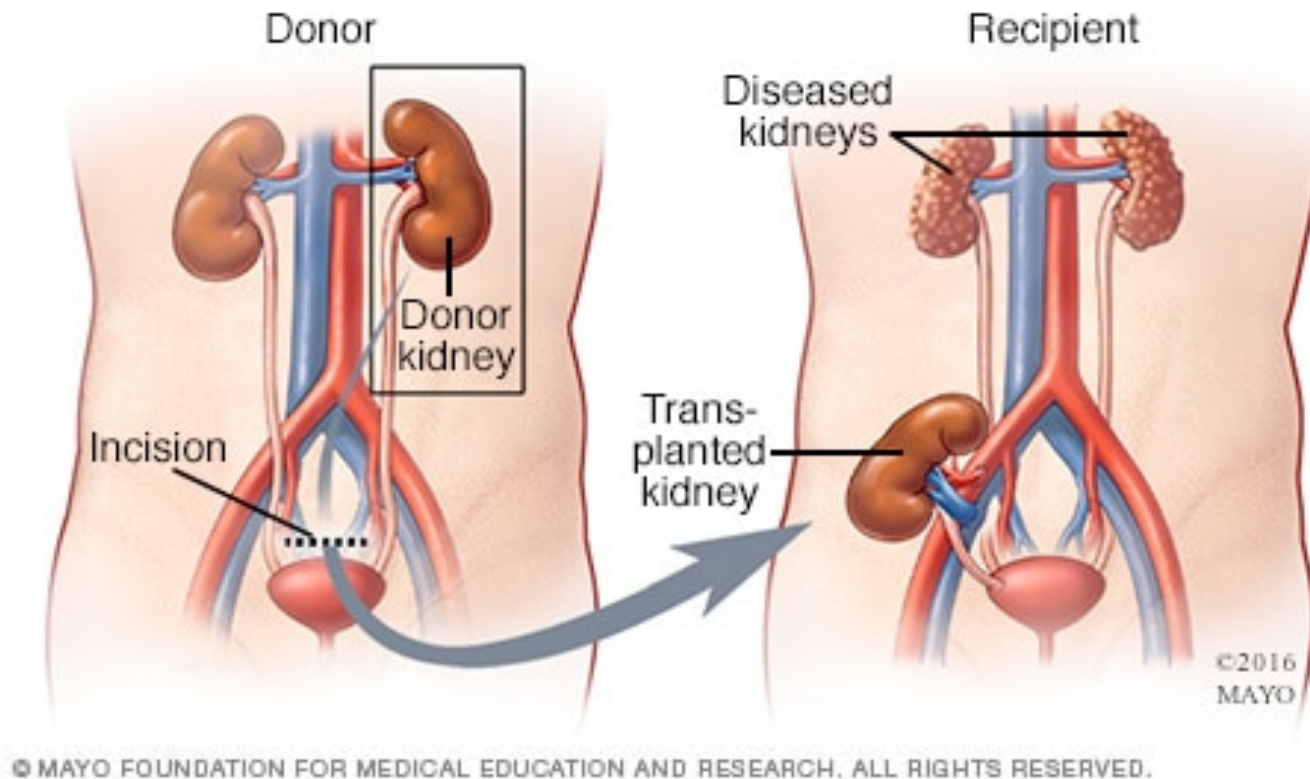


Transplant Surgery

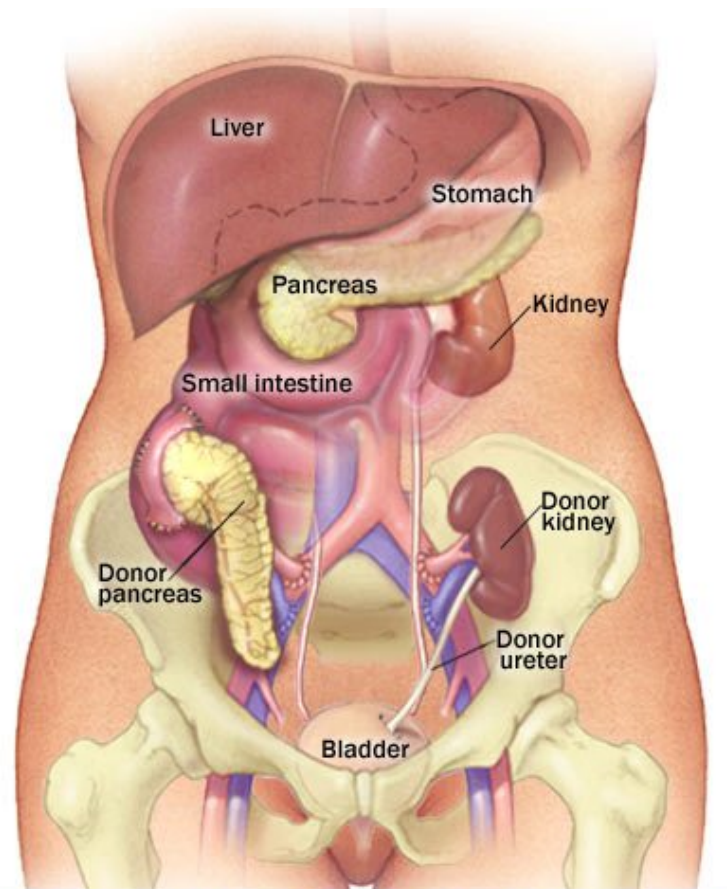


- Medications
 - Induction Therapy (Started Perioperatively)
 - Thymoglobulin (Peripheral or Central Line)
 - Pre-Medicate with Tylenol, Benadryl, and steroid
 - Basilixumab (Simulect)
 - High Dose Steroid Taper (Methylprednisolone)

Kidney Transplant

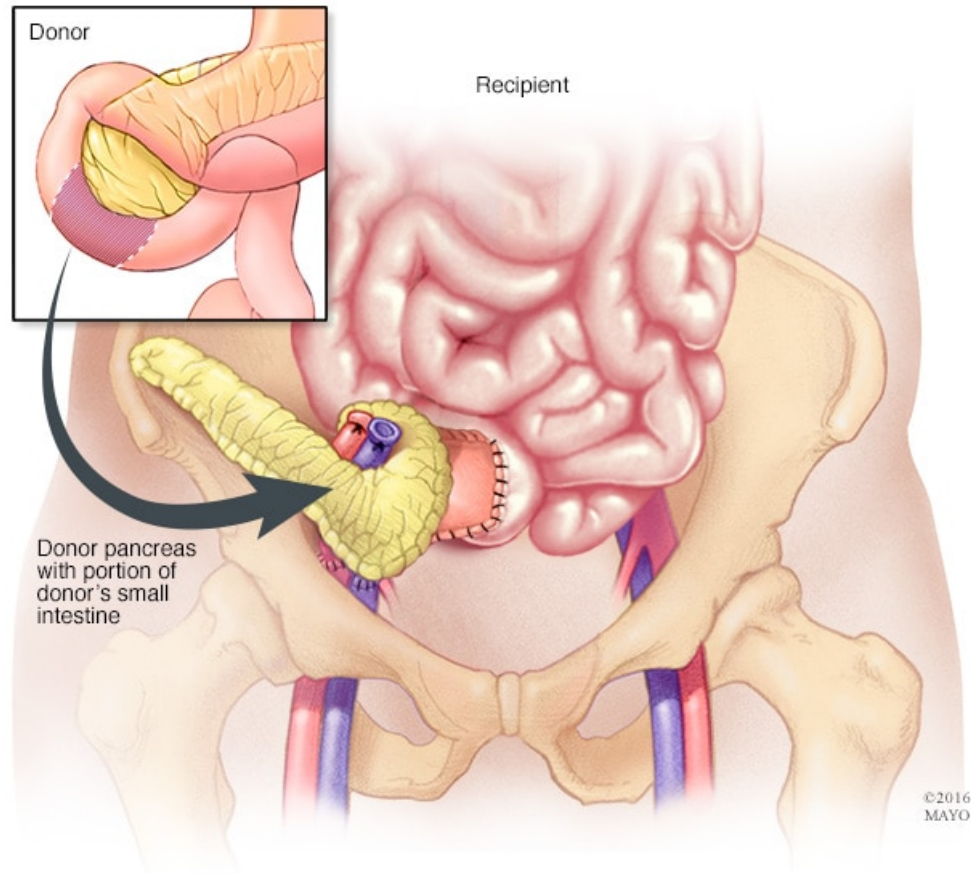


Simultaneous Kidney-Pancreas Transplant



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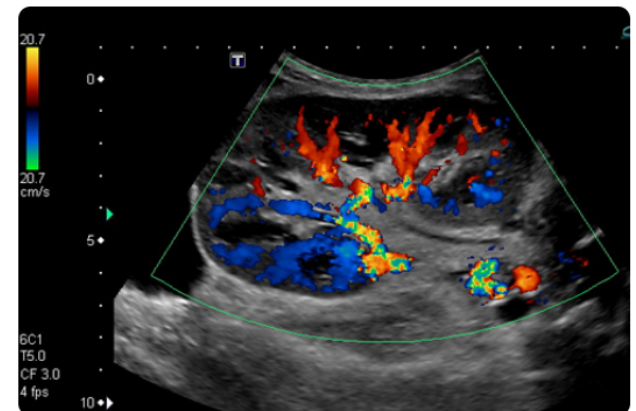
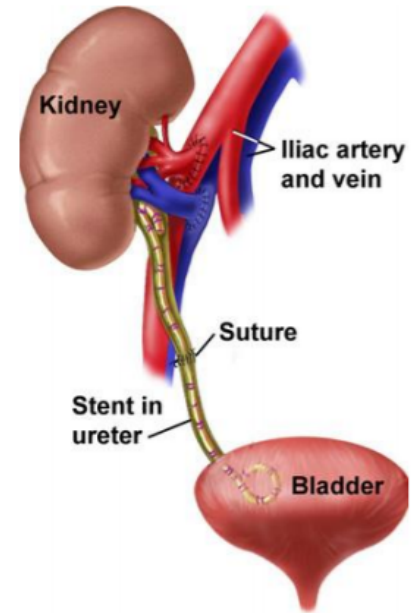
Pancreas Transplant



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Transplant Surgery

- Intra-Op
 - Ureteral Stent
 - Removed ~4-6 weeks post-op as outpatient
 - +/- JP drain
- Immediate Post-Op
 - **STAT US of allograft after OR**
 - R/O acute thrombosis
 - R/O anastomosis/perfusion abnormalities
 - Transfer to ICU or Step-Down
 - IV Fluid Replacement



Post-Transplant Management

- Inpatient Post-Op Management
 - Strict I&O
 - Red Flags:
 - Low UOP after living donor renal transplant
 - Drop in UOP in a patient who was previously urinating well
 - Fluid Replacement (IV/PO)
 - Daily Weights
 - Daily labs
 - Immunosuppressant trough levels
 - Amylase and Lipase for panc recipients
 - Foley Removal
 - Per attending ONLY
 - Usually POD 3-5 (avoid rupture of anastomosis site)
 - Notify transplant team if patient does not urinate w/in 1 hour of foley removal
 - Glucose Monitoring
 - Notify attending if panc recipient requiring more than 10u insulin/day



Post-Transplant Management

- Medications

- Maintenance Immunosuppression

- Started and dosed per attending
 - To be taken for the **LIFE** of the allograft to prevent rejection. It pts skip or change doses on their own, risk losing graft.

- Maintenance Agents

- Calcineurin Inhibitors: Tacrolimus or Cyclosporine
 - Anti-Metabolite: Mycophenolate or Azathioprine
 - Steroids: Prednisone
 - mTOR Inhibitors: Sirolimus, Everolimus
 - Belatacept (newer med)- CD80/86 antagonist
 - Used in place of CNI

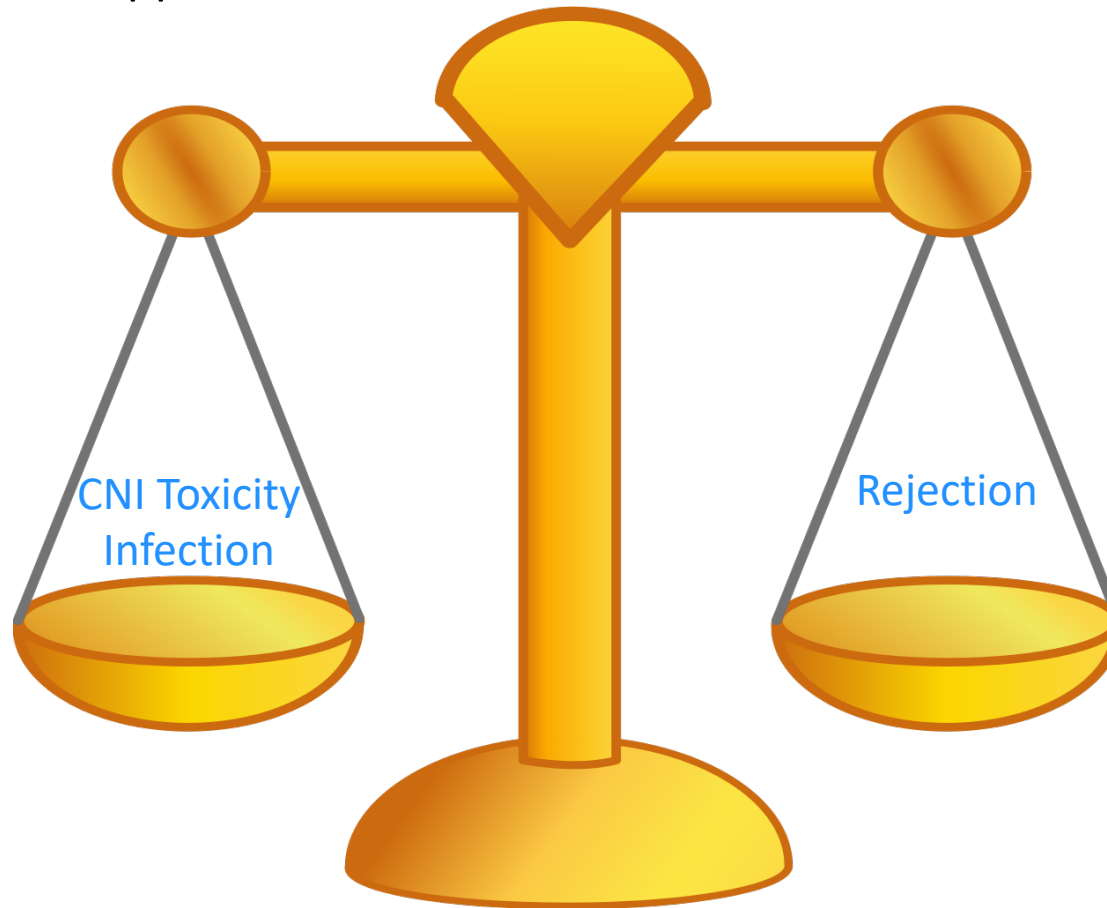
- Typical Regimen:

- Prograf (Tacrolimus) 1mg and/or 0.5mg (Monitor w/ trough levels)
 - Myfortic (Mycophenolate) 360mg
 - +/- Prednisone taper (eventually down to 5mg/day)



Post-Transplant Management

- Medications
 - Immunosuppression



Post-Transplant Management

- Medications
 - Infection PPX

Agent	Prevents	Notes
Trimethoprim/ sulfamethoxazole (Bactrim) (6 months)	PCP	If Sulfa Allergy, use Dapsone (check G6PD) or atovaquone. Adjust for renal function
Valganciclovir (Valcyte) (3-6 months)	CMV	Adjust for renal function
Clotrimazole (3 months)	Fungal Infection	1 Lozenge after meals

Post-Transplant Management

- Medications
 - Other
 - Magnesium
 - Phosphorus
 - Famotidine
 - BP meds (prn)
 - Insulin (prn)

Post-Transplant Management

- Medication Interactions
 - There are many meds/agents that interact with post-transplant meds.
 - Please be vigilant about checking for med interactions and/or consult pharmacy/transplant team prn prior to starting new agents (ex: Azole antifungals, antibiotics, antiseizure meds, etc.)



**Examples of common drug interactions of immunosuppressants used in solid-organ transplant:
Cyclosporine, tacrolimus, sirolimus, and everolimus**

Common types of drug interactions	Examples of interacting drugs	Approach to management in the absence of appropriate noninteracting alternatives
Coadministration of drugs that inhibit CYP3A metabolism and/or P-gp efflux can increase immunosuppressant serum concentrations , leading to significant toxicities.	<ul style="list-style-type: none"> Amiodarone ART-boosting agents (eg, ritonavir, cobicistat) Azole antifungals (eg, fluconazole, posaconazole, voriconazole) HIV protease inhibitors (eg, atazanavir, nelfinavir, saquinavir) Macrolide antibiotics Non-dihydropyridine calcium channel blockers Ombitasvir-paritaprevir-ritonavir with or without dasabuvir (an HCV, direct-acting antiviral regimen) Grapefruit juice 	<ul style="list-style-type: none"> Closely monitor immunosuppressant concentrations and signs of toxicity (eg, tremors and headaches). Substantial, including preemptive, dose reduction of immunosuppressant drug may be needed (eg, on average, only 25% of the standard dose of cyclosporine is required if administered concomitantly with HIV protease inhibitors). Some combinations are considered contraindicated according to product labeling; refer to appropriate topic reviews for detail. Lists of CYP3A and P-gp inhibitors are provided as separate tables within UpToDate.
Coadministration of drugs that induce CYP3A metabolism and/or P-gp efflux pumping can decrease immunosuppressant serum concentrations , increasing the risk of organ rejection.	<ul style="list-style-type: none"> Antiepileptic drugs, enzyme inducing (eg, carbamazepine, fosphenytoin, phenobarbital, phenytoin, primidone) Enzalutamide Nafcillin Rifamycins (eg, rifabutin, rifampin, rifapentine) St. John's wort 	<ul style="list-style-type: none"> Closely monitor immunosuppressant serum concentrations and signs of organ rejection. Significant immunosuppressant dose increases may be needed. Enzyme induction can require up to two weeks to achieve maximum effect and persists for up to two weeks after discontinuation of the interacting medication. Clinically significant effects can occur within hours to days of starting a CYP inducer. Lists of CYP3A and P-gp inducers are provided as separate tables within UpToDate.
Coadministration of nephrotoxic drugs with cyclosporine or tacrolimus can cause additive or synergistic kidney injury .	<ul style="list-style-type: none"> Aminoglycosides Amphotericin B Colchicine Nonsteroidal antiinflammatory drugs (NSAIDs) 	<ul style="list-style-type: none"> Concomitant administration of cyclosporine and tacrolimus with other potentially nephrotoxic drugs should be avoided. Suggested dose adjustments for use with colchicine are available in the Lexicomp monograph included within UpToDate.
Coadministration of drugs that increase serum potassium with cyclosporine or tacrolimus may cause severe hyperkalemia .	<ul style="list-style-type: none"> ACE inhibitors/ARBs Amiloride Spirolactone Triamterene Trimethoprim, trimethoprim-sulfamethoxazole (cotrimoxazole) 	<ul style="list-style-type: none"> Closely monitor serum potassium levels.
Coadministration of cyclosporine with sirolimus can increase sirolimus concentrations .	<ul style="list-style-type: none"> Cyclosporine 	<ul style="list-style-type: none"> Separate administration of sirolimus from cyclosporine by four hours; give sirolimus at a consistent time with respect to cyclosporine. Closely monitor immunosuppressant serum concentrations.
Coadministration of statin drugs with cyclosporine can increase statin levels and risk of myotoxicity .	<ul style="list-style-type: none"> Atorvastatin Lovastatin Pitavastatin Rosuvastatin Simvastatin 	<ul style="list-style-type: none"> Pravastatin and fluvastatin are preferred due to decreased interactions. Tacrolimus may be preferred over cyclosporine in patients receiving statin therapy. Cyclosporine and simvastatin should not be used together. Some combinations are considered contraindicated or statin daily dose limits are recommended in the product labeling; refer to the Lexicomp monographs included within UpToDate for detailed information.

- Important note:** The interactions listed in this table illustrate some of the common types of interactions with immunosuppressive drugs; this is **not** a complete list, and many other significant drug interactions can occur.
- Cyclosporine, tacrolimus, sirolimus, and everolimus are highly dependent upon CYP3A metabolism for clearance and are also substrates of P-gp drug efflux pump. Some interactions can lead to subtherapeutic or dangerously toxic levels of immunosuppressant concentrations.
- When appropriate noninteracting alternatives are readily available, consider modifying treatment to avoid combined use with potent metabolic inhibitors/inducers or agents known to have additive toxicities with immunosuppressants.
- Drug therapy should be managed by transplant specialists with expertise in therapeutic drug monitoring, and doses should be adjusted based upon measurement of immunosuppressant concentrations, particularly whenever drug therapy is altered. If there are any concerns about the safety of a given medication or supplement, they should be discussed with the patient's transplant center prior to initiation.



Post-Transplant Management

- Medication Side Effects

	Mechanism of Action	Side effects
Tacrolimus	Calcineurin inhibitor	NODAT (33%) Tremor/Insomnia Type 4 RTA ,Renal magnesium wasting Hair loss Drug induced TMA CNI renal toxicity
Cyclosporine	Calcineurin inhibitor	NODAT (20%) Salt sensitive hypertension Hypercholesterolemia Gingival Hyperplasia, Hirsutism Drug induced TMA CNI renal toxicity

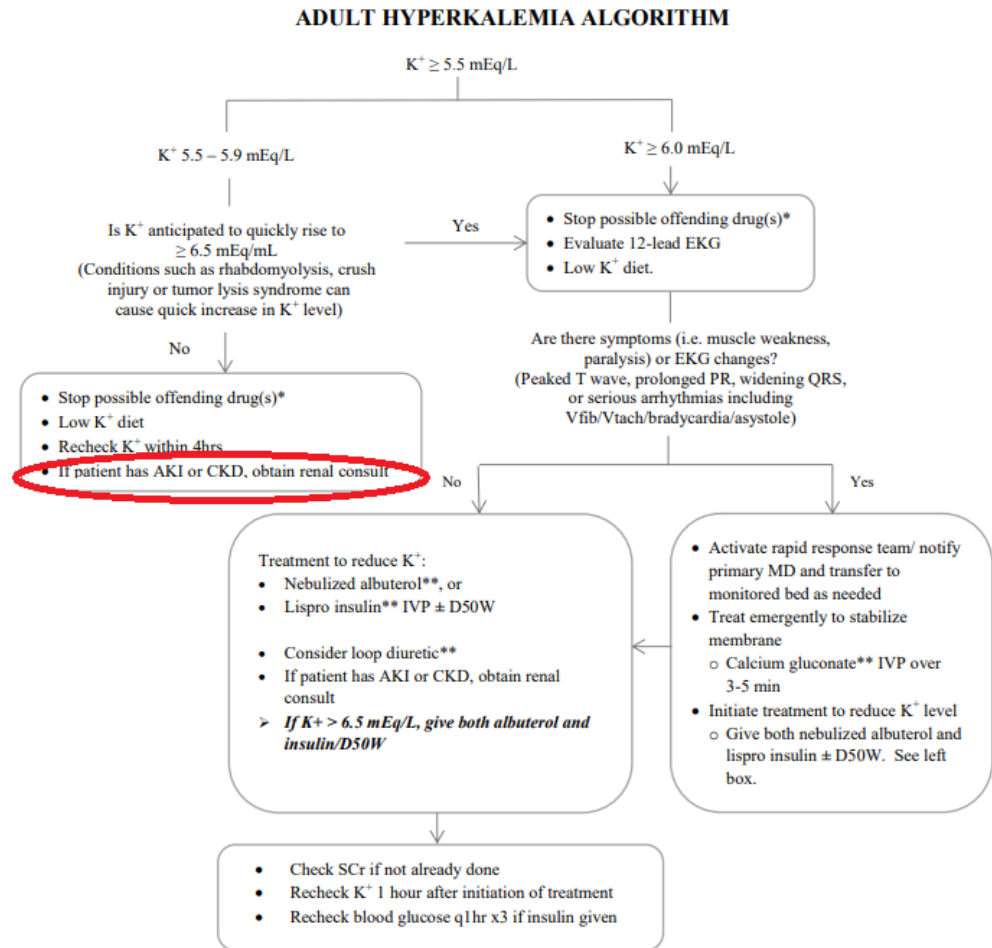
Post-Transplant Management

- Medication Side Effects

	Mechanism	Side effects
Sirolimus/ Everolimus	mTOR inhibitor	Proteinuria Lymphedema Poor wound healing/lymphocele Interstitial pneumonitis Hyperlipidemia Anemia Oral ulcers Higher risk of acute rejection
Belatacept	Costimulator inhibitor	PTLD in EBV naïve patients Higher risk of acute rejection
Tofacitinib	JAK 3 inhibitor	PTLD in EBV naïve patients Increased risk of infection Higher risk of acute rejection

Post-Transplant Management

- Hyperkalemia
 - Consult Transplant Nephrology
 - Avoid Kayexalate
 - Risk of ischemic necrosis, colonic dilatation and perforation



* See table below for list of possible offending drugs

** See page 2 for dosing recommendation table and additional information

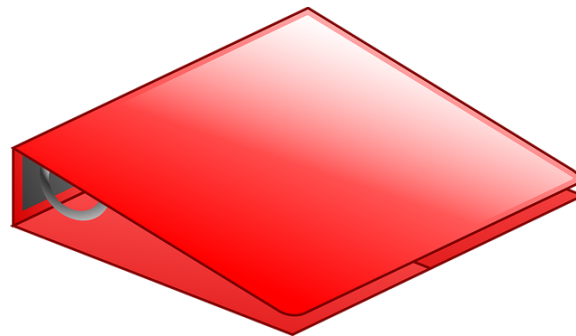
Post-Transplant Management



- Hypertension
 - **SBP Goal 120-160** (may vary based on recipient age, donor factors, baseline BP, etc.)
 - If SBP >160, consider clonidine, IV hydralazine, or increase dose of current BP meds
 - **Consult Transplant attending or Transplant Nephrology prior to adding BP meds**
 - AVOID ACE-I and ARBs in acute post-transplant phase
 - Severe HTN → consider RAS

Post-Transplant Management

- Patient/Family Education
 - Daily education with interdisciplinary care team while inpatient in anticipation for discharge/post-transplant life
 - Meds
 - Home care
 - Infection Prevention
 - Follow up
 - Sent home with printed materials/logs (“binder”), BP cuff, thermometer, glucometer (if needed), urinal/hat, pill box, meds, med list, transplant team contact info for 24/7 emergencies
 - Education continues outpatient with interdisciplinary care team



Post-Transplant Management

- Key Patient Education Points

- Monitoring BP, glucose, UOP, temperature, & weight
- Meds/Side Effects/Refills, always carry list
- Labs → Fasting (monitoring for NODAT). Never take tacrolimus before blood draw, take immediately after.
- Signs/Symptoms of infection/rejection
 - Fevers, chills, decreased UOP, pain over allograft, erythema at surgical site, etc.
- Fluid Intake Recs
 - ~2-3L/day, avoid sugary drinks
- Skin Protection (increased risk for skin CA d/t immunosuppression)
 - SPF 30+, hat, long sleeves
- HCM/Cancer Screenings (Pap, Mammo, Colo, Prostate CA Screening, etc.)
- Activity (walking, no heavy lifting until cleared, no driving ~1 month)
- Hand Hygiene/Infection Control
- No grapefruit, pomegranate, or supplements w/o MD approval (med interactions)
- No live vaccines

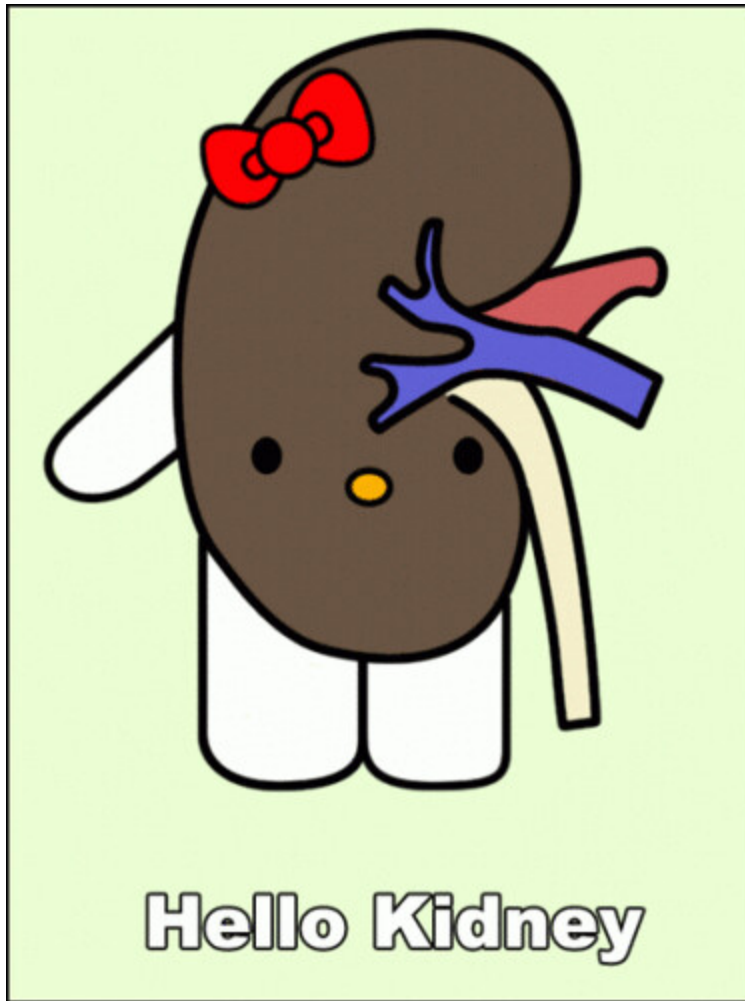


Post-Transplant Management

- <90 Days (“Acute-Post”)
 - Highest level of immunosuppression
 - Increased risk for infection
 - No vaccines within first 90 days (ex: influenza) w/o MD approval
 - Frequent lab and clinic visits (at least 2x/week for 1st month, then taper down according to clinical course)
 - Adjusting immunosuppression, taper Steroid
 - Assessing allograft function (UOP, Cr, Urine Protein)
 - Screening/monitoring for infections (CMV, BK, UTI, etc.)
 - Monitoring wound healing, drain removal
 - BP/Blood Glucose management
 - Ureteral Stent removed in Urology 4-6 weeks after transplant
 - Bone Mineral Disease/Electrolytes (PTH, Vitamin D, Calcium, Phos, Mg)
 - Supplement prn




Post-Transplant Management

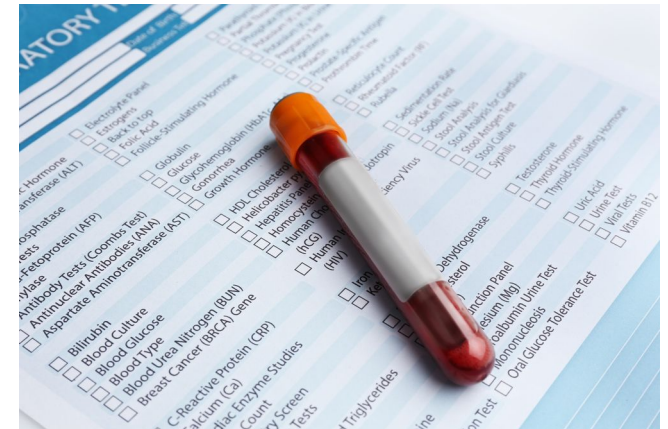


- >90 days post-transplant (“Long-Term Post”)
 - Seen every 1-3 months for the first year, then every 3 months for the first 3 years
 - Repatriate back to Nephrologist/PCP after ~3-6 months post-transplant
 - Good communication/coordination of care is essential
 - Return to work/activities at discretion of care team

Post-Transplant Complications

- Elevated Cr

- Post-transplant, baseline Cr tends to be a little higher
 - Single kidney, ischemic injury (deceased donor), Kidney Quality (high KDPI), Calcineurin inhibitors (Vasoconstriction, ATN), size mismatch
 - Allograft dysfunction
 - Pre-Renal (over-diuresis, under hydration, diarrhea, GI issues)
 - Post-Renal (obstruction)
 - CNi toxicity
 - Allograft rejection
 - Acute Cellular Rejection
 - Antibody Mediated Rejection
 - Recurrent Glomerulonephritis
 - De Novo Renal Diseases (ATN, toxins)
 - Drug induced acute interstitial nephritis
 - Renal Artery Stenosis
 - Infection (Pyelonephritis, BK nephropathy)
- 
- A close-up photograph of a medical laboratory test form. The form is white with blue and black text, listing various tests such as 'Electrolyte Panel', 'Liver Function Tests', 'Kidney Function Tests', and 'Infectious Disease'. A red blood test tube with a white cap is resting diagonally across the middle of the form. The background is a solid blue color.



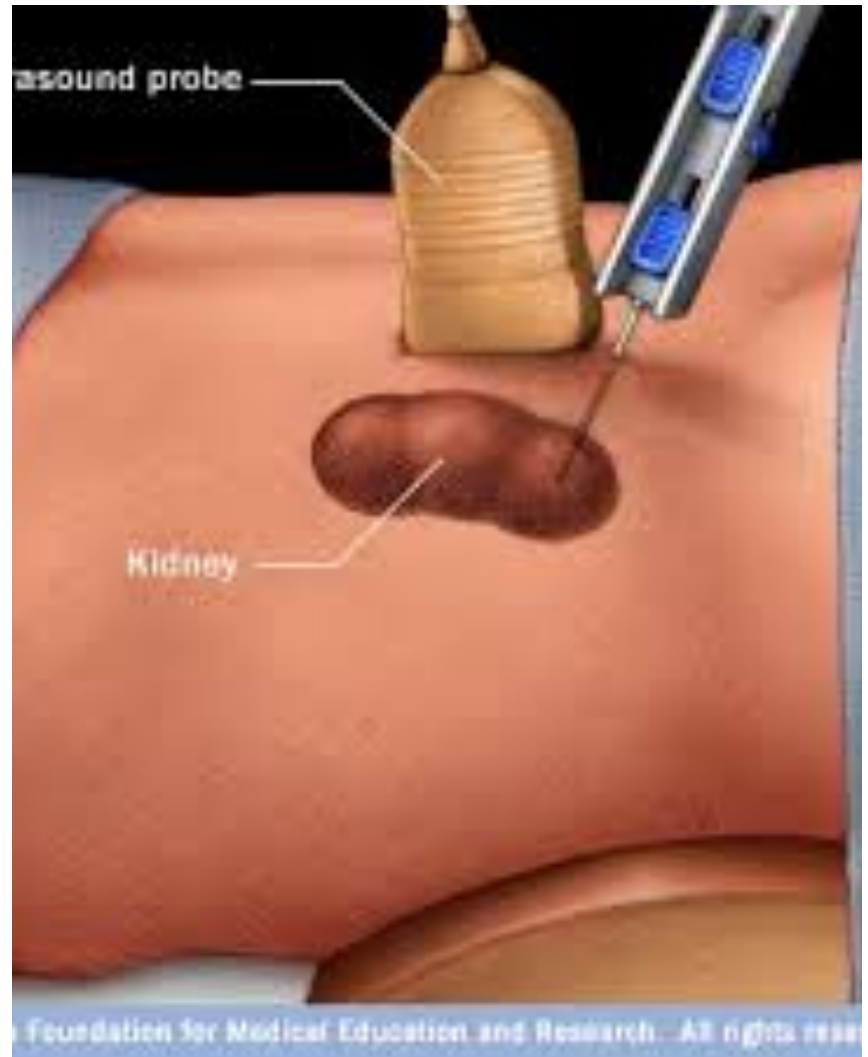
Post-Transplant Complications

- Proteinuria
 - Recurrent Disease
 - FSGS
 - IgA Nephropathy
 - Membranous Nephropathy
 - Diabetes
 - De Novo Disease
 - Transplant Glomerulopathy
 - Secondary FSGS
 - Diabetes



Post-Transplant Complications

- Renal Biopsy
 - Indications
 - Concern for rejection
 - Unexplained rise in Cr
 - Concern for BK nephropathy
 - Evaluate for recurrent disease
 - Proteinuria >1g/day
 - Protocol Biopsy
 - Risks
 - Bleeding
 - Damage to other organs
 - Infection
 - Loss of allograft (rare)



Post-Transplant Complications

- Immunosuppression Side Effects
 - ↑ Blood glucose
 - ↑ BP
 - ↑ Lipids
 - ↑ Weight
 - ↓ Magnesium levels
 - ↓ Phosphorus levels



Post-Transplant Complications

- NODAT (New Onset Diabetes After Transplant)
 - While on dialysis, DM may be “hidden” d/t insulin metabolism and excretion
 - Transplant kidney → gluconeogenic
 - Immunosuppression can increase blood sugars (Tacrolimus, Steroids)
 - Pre-existing RF may predispose recipient to DM
 - Usually develops w/in first few months after transplant. Continue to check fasting sugars/HgbA1C.
 - Treatment
 - Medical management
 - Diet
 - Exercise
 - Weight loss



Post-Transplant Complications

- Infection

- Increased risk of infection d/t chronic immunosuppression
 - Highest risk within first 1-3 months d/t higher levels of immunosuppression, however, can occur any time.
- Major cause of allograft loss and recipient death
- Common Infections
 - URIs
 - UTI's
 - Most common bacterial infection s/p renal transplant
 - Ureteral stents placed at time of transplant (removed 4-6 wk post-op) may cause UA to look positive
- Opportunistic Infections
 - Cytomegalovirus (CMV)
 - Polyomavirus (BK and JC virus)
 - Pneumocystis jirovecii Pneumonia (PCP)



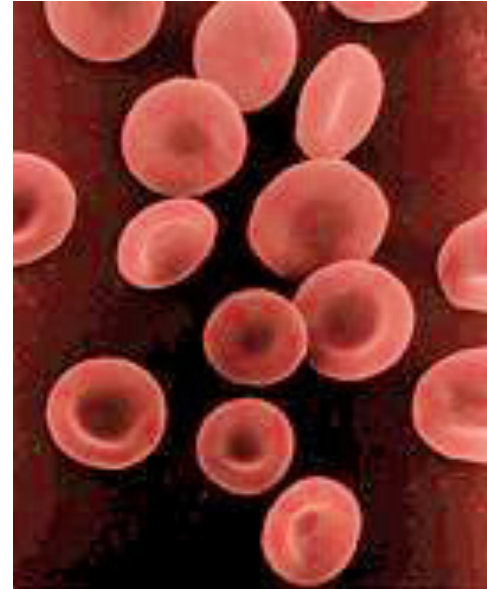
Post-Transplant Complications

- Cardiovascular Disease
 - CVD remains major cause of death and graft loss in DM renal transplant pts
 - Risk Factors for CVD
 - ESRD
 - Anemia
 - DM
 - HTN
 - Obesity
 - Immunosuppressive therapies can worsen some of these risk factors



Post-Transplant Complications

- Anemia
 - Most pts with ESRD are anemic at time of transplant
 - Transplant factors can perpetuate anemia
 - Surgical blood loss
 - Inflammation
 - DGF (Delayed Graft Function)
 - Induction/Immunosuppression
 - Antiviral Agents
 - DC of erythropoietin stimulating agents
 - Usually recovers in 6-12 months with good allograft function, however, can re-develop with allograft dysfunction, infection, and/or use of ACE/ARB.



Post-Transplant Complications

- Post-Transplant Erythrocytosis
 - Persistently elevated Hgb/Hct after transplantation (Hgb>17, Hct>51%)
 - Treatment
 - ACE/ARB
 - Phlebotomy (severe cases)



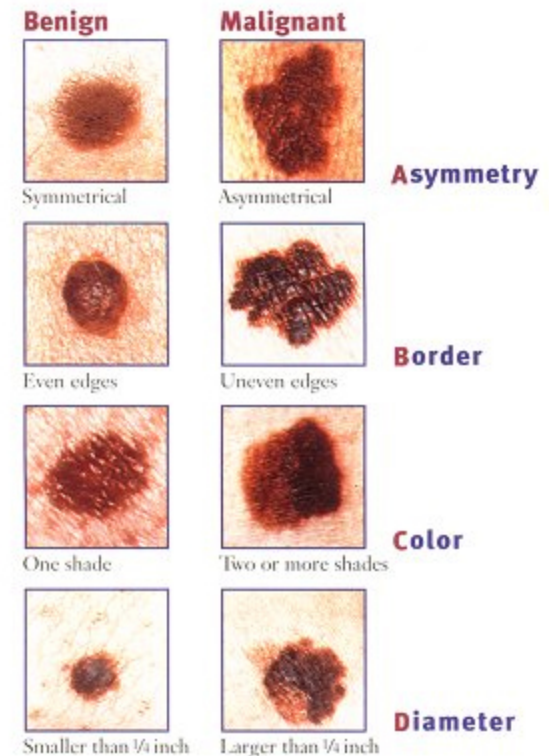
Post-Transplant Complications

- Obesity
 - Many patients are obese/morbidly obese prior to transplant
 - Post-transplant weight gain may be related to increased appetite, steroids, and feeling better in general once off dialysis.
 - Treatment
 - Lifestyle modifications
 - Diet
 - Exercise



Post-Transplant Complications

- Malignancy
 - Increased risk of CA s/p transplant d/t immunosuppression
 - 3rd most common cause of death in renal transplant recipients
 - Increased risk in transplant population
 - Skin Cancer
 - Highest risk
 - Regular Derm screenings
 - Minimize sun exposure, use UV blocking agents
 - Post-Transplant Lymphoproliferative Disease (PTLD)
 - Lymphoid and/or plasmacytic proliferations related to immunosuppression
 - Most common malignancy after skin CA in SOT recipients
 - Kaposi Sarcoma
 - Non-Hodgkin Lymphoma
 - Liver Cancer
 - Anus/Lip/Vulva Malignancies



Figures are provided courtesy of Robert J. Friedman, MD.

Vaccines

- Want patients vaccinated prior to transplant as much as possible.
- **NO LIVE or LIVE ATTENUATED vaccines after transplant**

INTERNATIONAL CERTIFICATE OF VACCINATION OR PROPHYLAXIS
Certificat international de vaccination ou de prophylaxie

This is to certify that (1) Jane Mary Doe (2) 22 March 1960 (3) F United States
 Nous certifions que (name - nom) (date of birth - née) (le) (sex - de sexe) (nationality - et de nationalité)

(National identification document, if applicable - document d'identification nationale, le cas échéant) [passport number] whose signature follows (3) Jane Mary Doe
 dont la signature suit

has on the date indicated been vaccinated or received prophylaxis against (4) Yellow Fever in accordance with the International Health Regulations.
 a été vaccinée) ou a reçu une prophylaxie à la date indiquée (name of disease or condition - nom de la maladie ou de l'affection) conformément au Règlement sanitaire international.

Vaccine or prophylaxis Vaccin ou agent prophylactique	Date	Signature and professional status of supervising clinician Signature et titre du professionnel de santé responsable	Manufacturer and batch no. of vaccine or prophylaxis Fabricant du vaccin ou de l'agent prophylactique et numéro du lot	Certificate valid from: until: Certificat valable à partir de : jusqu'à :	Official stamp of the administering center Cachet officiel du centre habilité
Yellow Fever	15 June 2018	John M. Smith, MD	Batch (or lot) #	(7) 25 June 2018; life of person vaccinated	[(B)]

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Vaccines

- **DO NOT** GIVE THESE VACCINES TO TRANSPLANT RECIPIENTS
 - Varicella Zoster
 - Intranasal influenza
 - Bacillus Calmette-Guerin (BCG)
 - Oral Typhoid
 - Measles
 - Mumps
 - Rubella
 - Oral Polio
 - Live Japanese B Encephalitis
 - Yellow Fever
 - Smallpox

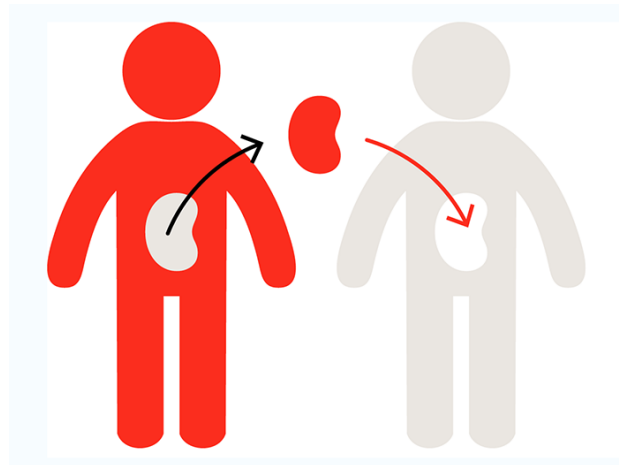


Vaccines

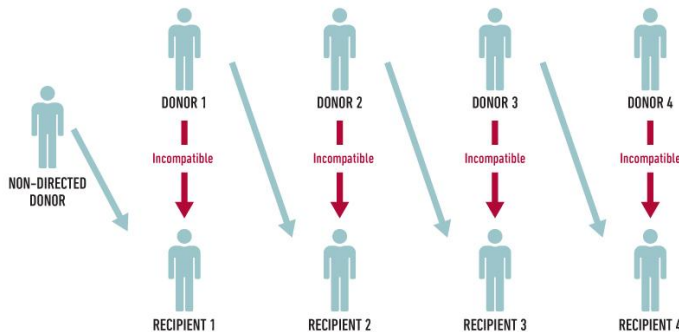
- Vaccines that are OK after transplant
 - Inactive Influenza Type A and B (annually)
 - Pneumovax (Prevnar-13 q3-5 years)
 - Haemophilus Influenza B
 - Hepatitis B
 - Typhoid Vi
 - Inactivated Polio
 - Meningococcus
 - Hepatitis A
 - Covid-19 Vaccine
- Consult with transplant attending for any vaccines being considered <90 days post transplant



Living Donors



- **Extraordinary Population** that willingly gives up a kidney to help another in need (related or unrelated)
- Donor safety/health is paramount
- Separate donor team
- Inpatient s/p Donor Nephrectomy
 - MUST go to 66/68 for post-op care
 - Must void w/in 2 hours post foley removal
 - Pain Management (usually healthy, may not have had surgery before)



Living Donors



Patricia Lovenstein and Frank Maggelet before transplant surgery.

<https://www.ucihealth.org/blog/2016/01/3000-miles-to-donate-a-kidney>



Xenia Morales, left, and her older sister, Nadia.

<https://www.ucihealth.org/blog/2018/06/kidney-donation>

Confidentiality

- Protecting donor confidentiality (living AND deceased donors) is of vital importance. Must maintain recipient confidentiality as well.
- Exclude identifiable information about donors in notes, conversations with patients/family.
- Defer to the transplant team if the patient is asking about specific donor details.



shutterstock - 174129806

Reference Tools

UC Irvine Transplant Resident Pocket Guide: January 2019

Day of Surgery:

- Order set: UCI IP TXP KIDNEY OR KIDNEY/PANCREAS TRANSPLANT CLINICAL PATHWAY PRE OP
- Do a full H&P on deceased donor transplant recipients; on living donor transplant recipients if recent H&P not present in eMAR.
- Discuss case with Transplant attending.
- Consult Transplant Nephrology (Dr. Reddy/Ekamol or general nephrology pager). Some patients may need HD prior to surgery based on schedule/labs.
- For deceased donor transplants, order CXR, EKG, CMP, CBC, PT/INR, PTH, serology screenings on day of transplant for deceased donors (on order set) Confirm pre-op testing done for living donor transplants
- Consent form, name of procedure: "Deceased donor renal transplant with possibility of ureteral stent placement". Living donor consented in clinic prior to transplant

Induction agent:

- either thymoglobulin OR simulect per attending surgeon

OR Induction agent	Administration	Pre-medications
Anti-thymocyte globulin (Thymoglobulin) Always confirm dose and duration with attending. Pre-op: Order peripheral concentration on call to OR.	Dose is 1.25 mg/kg rounded to the nearest 25 mg (usually 50-125 mg per dose, duration usually 4-5 days starting in OR). Post-op: Order central or peripheral route as appropriate. -For daily evaluation of dose, order CBC with differential. Goal is to have absolute lymphocyte count of 0.1 or less. Consider decreasing dose if WBC < 2 or if platelets < 50.	pre-medications: -tylenol 650 mg -benadryl 50 mg -methylprednisolone 30 mg IV (if IV steroids not already ordered 1 hour before), ok to give w/ PO prednisone
Basiliximab (Simulect)	Give on POD #0 and 4 via peripheral or central line	none

- IV methylprednisolone 500 mg in OR for all patients, then taper post-op
- Nurse to call for induction medications prior to surgery, pharmacy IV room extension is 456-5981

Post-Transplant Care:

- Order sets: UCI IP TXP KIDNEY OR KIDNEY/PANCREAS TRANSPLANT CLINICAL PATHWAY POST OP
- Order a STAT ultrasound of transplant kidney after OR
- DGF (delayed graft function) is any patient that requires dialysis within the first 7 days of transplant. Dialysis (at any time) should be only ordered by surgical attending or transplant nephrologist Dr. Reddy/Ekamol.
- Consult with transplant nephrology for medical issues (BP management, etc)
- Make note of stents and drains placed. Monitor daily JP output, drain removal per attending only
- Order daily weights and labs. Assess in's and out's and volume status daily.
- IV replacement fluids: 1 ml of 0.45%NS given for each 1 ml of UOP greater than maintenance fluids.
- Management of low urine output: Assess for foley patency. Discuss with attending or nephrology team for further interventions such as IV fluid bolus, IV lasix bolus, or STAT Ultrasound. Sometimes, low UOP is expected if we suspect ATN/DGF. Be concerned about low UOP after a living donor renal transplant, or a drop in UOP in a patient who was previously urinating well.
- Foley removal- Per attending's discretion (usually POD 3-5). To avoid rupture of anastomosis site after the foley is removed, include nursing instructions in foley removal order, "notify transplant resident if patient does not urinate within 1 hour of foley removal".
- Order a nutrition consult within 24 hours of transplant
- Infectious prophylaxis:

	Prevents	Note
Bactrim	PCP	-if sulfa allergy, Dapsone (check G6PD) or atovaquone -Adjust dose for renal function
Valcyte	CMV	Adjust dose for renal function
Clotrimazole	Fungal	1 lozenge after meals

Endocrine:

- Monitor blood glucose: insulin sliding scale for all patients, for diabetic patients do not re-start home oral diabetes agents
- Attending to be notified if more than 10 units of insulin is given per day for **Pancreas or Kidney-Pancreas** Transplant Patients
- Endocrinology should be consulted on all diabetic patients who have an insulin pump

Reference Tools

Post-Transplant Medical Considerations:

- Hyperkalemia: To avoid hypoglycemia from insulin IVP+ dextrose, consult with transplant nephrology prior to ordering. Nephrology will consider HD if K⁺ is >6 in a patient not making urine. Avoid giving Kayexalate (due to risk of ischemic necrosis, colonic dilatation and perforation).
- Elevated blood pressure: discuss with attending or Nephrology team regarding addition of BP meds, or restarting home BP meds. If SBP is < 160, no acute intervention is required. If BP >160, consider clonidine, IV Hydralazine 10mg (usually ordered as PRN), or can increase dose of current BP meds. AVOID ACE-I and ARBs use in acute post-transplant phase.
- Acute Rejection: if patient has prolonged DGF or sudden decrease in urine output after previously urinating well, we will consider doing renal allograft biopsy to evaluate for rejection.

Post-Transplant Surgical Complications:

- Urine leaks or ureteral obstruction: if concern for urinary leak, we typically check JP creatinine
- Lymphocele: can usually be detected by renal allograft ultrasound.
- Infection: UA are often falsely positive due to urinary stent, so urine culture is confirmatory.
- Thrombosis: renal artery thrombosis, renal vein thrombosis, DVT – can be detected on renal allograft ultrasound with Doppler.
- Renal artery stenosis: suspect if patient having severe hypertension
- GI complications: ileus related to surgery or medications
- Hydronephrosis: can be evaluated by renal allograft ultrasound.
- Ureteral Stricture: IVP (intravenous pyelogram) can help identify this.
- Urinary reflux: can usually be detected by VCUG (voiding cystourethrogram)
- Acute segmental infarction

Immunosuppression trough levels:

- Tacrolimus to be started and dosed per transplant attending (dependent on patient condition)
- Tacrolimus, cyclosporine, everolimus should be dosed BID at 0800 and 2000 (Prograf and Astagraf NOT interchangeable)
- Order trough as "DAILY" at 0630 draw, with the following comments:
 - ICU: Nurse to at 0630 prior to morning dose
 - Non-ICU: Lab to draw between 0630-0800 prior to morning dose
- In early post-transplant patients, Prograf goal trough levels are typically 8-10 ng/ml (slightly higher if kidney-pancreas or re-transplant patient).

Living Donor Nephrectomy

- Admit donors to 66/68 post op
- PCA should be stopped 24 hours after initiation, transition to oral meds
- Foley should be removed 24 hours after insertion at attending's discretion
- Medications on discharge include stool softener and pain medications with comments "charge to kidney acquisition"

Transplant Service Re-admission/Consultation Guidelines:

- For Transplant patients under 1 year post transplant, these should be admitted to Transplant Surgery service (unless for neuro or cardiac reason)
- For Transplant patients 1-3 years post transplant, Transplant Surgery service will be consulted.
- For Transplant patients >3 years post transplant, okay to defer these patients to Transplant Nephrology only.
- If there is concern for rejection or confirmed rejection, these patients should be admitted to Transplant Surgery service.

Note: Transplant Nephrology should be consulted on all transplant patients.

Rejection

- Order set: *Acute cellular transplant rejection*
- In general 2 types of rejection: Cellular or Humoral (Ab mediated)
- Renal biopsy for diagnosis (clarify with IR and attending whether to HOLD aspirin, restart when appropriate)
- DSAs (donor specific antibodies) may be ordered per attending
- Rejection treatment options to be decided by attending: IV pulse steroids (5mg/kg x 3 days, then taper), Thymoglobulin, IVIG, plasmapheresis

Protecting Confidentiality

- Exclude identifiable information about donors in progress notes. For any reference to a donor age, use age range (ex. 40-50 years old).

Miscellaneous:

- AVOID PICC lines in transplant patients
- AVOID nephrotoxic agents such as contrast dye, aminoglycosides
- AVOID NSAIDs
- Place patients in private rooms due to increased risk of infection
- Transplant office phone (for follow up appointments, new transplant evaluation referrals): 714-456-8441

References:

1. Danovitch, G, *Handbook of Kidney Transplantation: Fifth Edition*. Lippincott Williams and Wilkins 2010.
2. McKay D, Steinberg S, *Kidney Transplantation: A Guide to the Care of Kidney Transplant Recipients*. Springer New York 2010

Reference Tools

UC Irvine Kidney and Pancreas Transplant Inpatient Nursing Reference Guide

Common Transplant Medications
Induction Agents <i>These medications may be given at the time of transplant to lower the patient's immune system in preparation for the new organ.</i> <ul style="list-style-type: none">• Basiliximab (Simulect)- Usually given on POD 0 and 4• Thymoglobulin- Must be given via central line. Dosed per MD.• Steroid Taper- Several days of IV steroids followed by oral steroid, for high risk patients.
Maintenance Immunosuppression Medications <i>These medications lower the immune system to prevent rejection of the transplanted organ(s). Patients will usually be on 2-3 of these meds at home.</i> <ul style="list-style-type: none">• Tacrolimus (Prograf)- Dosed twice per day. Requires drug level monitoring.• Tacrolimus Extended-Release (Envarsus XR or Astagraf)- Extended-release tacrolimus. Dosed once per day. Requires drug level monitoring. NOT interchangeable with tacrolimus immediate release.• Mycophenolate (Myfortic, Cellcept)• Prednisone• Cyclosporine (Neoral)- Requires drug level monitoring.• Everolimus (Zortress)- Requires drug level monitoring.
Anti-Infective Agents <i>These medications are used to prevent bacterial, viral, and fungal infections after transplant and/or after treatment for rejection.</i> <ul style="list-style-type: none">• Trimethoprim/Sulfamethoxazole (Bactrim SS)- Single strength tabs (NOT DS). Used to prevent bacterial infections/PCP.• Valganciclovir (Valcyte)- Used to prevent viral infections/CMV.• Clotrimazole (Mycelex)- Used to prevent fungal infections. <p><i>*Note: Each patient's medication regimen is individualized and may vary from the above listed medications.</i></p>

Drug Levels/Labs:

- Remember to check that labs were drawn prior to morning immunosuppression medication administration. The labs are ordered as "Timed Collection, Process STAT" at 0630.
- Who draws the labs:
 - **ICU:** RN to draw labs at 0630, prior to morning immunosuppression medication administration.
 - **All other units:** Lab to draw between 0630-0800, prior to morning immunosuppression medication administration.

- Reminder: Immunosuppression dosing is dependent on accurate trough drug levels.
- In early post-transplant patients, Tacrolimus goal trough levels are typically 8-10 ng/ml (slightly higher if kidney-pancreas or re-transplant patient).
- Tacrolimus and other immunosuppressant goal trough levels are set by the transplant attending physicians.

Post Op Ultrasound

- All patients should have a STAT transplant ultrasound after OR. Page the attending physician if this has not been done within 1 hour after OR.

Urine Output

- Key in assessing renal function. MUST be monitored/charted per order.
- Page the transplant team immediately for:
 - Decreased urine output in any renal transplant patient that was previously making good urine output.
 - No urine output in a living donor kidney recipient.
 - New or worsening hematuria.

Foley Removal

- Fresh renal transplant patients MUST void within 1 hour of foley dc. If not voiding within 1 hour, page transplant MD immediately.
- After foley removal, patient should void q 2-3 hours while awake.

Daily Weights

- Weight must be documented DAILY on all renal transplant patients. This information is important in assessing fluid status.

Pain

- If patient c/o sudden onset of pain or severe pain over the transplant site, page the transplant attending, surgical resident, and ICU team (if patient is in the ICU) for urgent evaluation (ex: r/o thrombosis, urine leak, acute rejection, etc.)

Incentive Spirometer (IS)

- Ordered daily. Teach and monitor IS use closely. Preventing post-surgical respiratory complications is especially important in immunocompromised patients.

Pancreas Transplant Recipients

- Should have amylase and lipase ordered daily
- Monitor glucose levels closely, as this correlates with pancreas function. Notify transplant team immediately for abrupt changes in glucose levels.
- Notify transplant attending if more than 10 units of insulin is given per day for Pancreas or Kidney-Pancreas Transplant recipient.

Hyperkalemia

- For all potassium values >5.5, the Transplant Nephrology team should be notified.
- AVOID Hyperkalemia protocols in which dextrose & insulin are given.
- AVOID Kayexalate in the immediate post-transplant surgery period.

Reference Tools

Infection Control While Inpatient

- All patients on transplant surgery service must be in a PRIVATE ROOM. All other transplant patients should be in a private room whenever possible. Please contact a transplant attending for any level of care questions regarding a particular patient.
- Follow hospital policy for standard precautions. Please encourage visitors to wash their hands. Avoid sick contacts. No fresh flowers or animals.

Patient Education

- It is important for inpatient nursing team to participate in post-transplant teaching. Remember to document your teaching in the EMR.
- Important teaching points:
 - Fluid Intake- As renal function improves, most patients need to drink ~2-3 liters per day (more if UOP >3L/day). Fluid intake recommendations will be given to each patient by the transplant team.
 - Home logs:
 - Urine Output
 - Blood pressure
 - Temperature
 - Daily Weights
 - Blood sugars (if advised by transplant team)
 - Medication compliance- Meds are for the LIFE of the transplant. Missed doses (for ANY reason) can lead to complications/rejection.
 - No heavy lifting (no more than 10 lbs)
 - DM education (if applicable)- monitoring blood sugars, signs/symptoms of hypoglycemia/hyperglycemia, medications
 - JP care/measuring (if going home with JP)
 - Foley care (if going home with foley)

Immunizations

- Check with transplant team prior to the patient receiving any vaccines within the first 90 days after transplant.
- After 90 days, INACTIVATED vaccines are okay to give. Inactive influenza vaccine should be given annually. Pneumococcal vaccines should be given per protocol.
- No LIVE or LIVE ATTENUATED vaccines (ex: Varicella (chicken pox), Zoster (shingles), intranasal influenza, MMR, etc.) for post-transplant patients.

Nutrition

- Diet orders are advanced per RD recommendation. If the kidney is working well, a regular diet will be ordered. A high fiber, low fat diet is encouraged due to long term risks of weight gain, hyperlipidemia, and hyperglycemia post-transplant.
- Diet orders will be customized for patients' individual needs, especially for diabetes, high blood pressure, and/or any other nutrition concern.
- NO grapefruit, pomegranate, or herbal supplements are allowed due transplant medication interactions (which could lead to neutropenia or transplant rejection).
- Food safety: All meats need to be thoroughly cooked. Fresh fruits and vegetables need to be washed well before consumption.

Psychosocial

- Patients and/or their loved ones may have mixed emotions. Please alert transplant social work and/or transplant team members to any concerns/issues.

Living Donors

- This is a special population. MUST be on 66 or 68 for post op care.
- Donors should void within 2 hours post foley removal. If unable to void, contact the transplant team immediately.
- Should have daily labs (at least CMP, CBC)

Protecting Confidentiality

- Exclude identifiable information about donors in notes. For any reference to donor age, use age range (ex. 40-50 years old).
- Defer to the transplant team if the patient is asking about specific donor details.

Rejection

- In general 2 types of rejection: Cellular or Humoral (Ab mediated)
- Renal biopsy for diagnosis (may need to HOLD aspirin/anticoagulant and then restart when appropriate)
- DSAs (donor specific antibodies) may be ordered per attending
- Rejection treatment options are decided by transplant attending. Examples are IV pulse steroids, Thymoglobulin, IVIG, plasmapheresis.

Post Renal Biopsy Management:

- Keep patient in bed for 4 hours post procedure.
- Post biopsy renal US should be done 4 hours post procedure.
- Monitor urine closely after biopsy for hematuria.

Miscellaneous:

- AVOID PICC lines in transplant patients.
- AVOID nephrotoxic agents such as contrast dye, aminoglycosides, etc.
- AVOID NSAIDs.

How to reach the transplant team

- Contact the transplant team for any questions or concerns regarding transplant patients. Please page a transplant attending directly as needed.

Transplant Physicians	
Resident Physician (Green Team)	Pager: 714-506-8000
Dr. Donald Dafoe Transplant Surgeon/Attending Physician	Pager: 714-506-1275
Dr. Hirohito Ichii Transplant Surgeon/Attending Physician	Pager: 714-506-9801
Dr. Uttam Reddy Transplant Nephrologist/Attending Physician	Pager: 714-506-0846
Transplant Office	Open 0800-1700, M-F Phone: 714-456-8441

Key Reminders

- No PICC Lines (need to preserve future access)
- STAT post-op US
- Meds are taken for the life of the organ
- Check for med/supplement interactions
- Consult Transplant Nephrology for hyperkalemia in renal transplant recipient
- Consult Transplant team prior to adding BP meds
- No Live Virus Vaccines
- Consult transplant for inactive vaccines considered <90 days post transplant
- Donors are special population
- Confidentiality for both donors and recipients
- Key Resources
 - Resident guide
 - Inpatient Nursing Guide
 - Transplant Team available 24/7

Key Contacts

- Transplant Office 714-456-8441
 - Open 0800-1630 M-F
 - Transplant Coordinator on call 24/7 for urgent/emergent issues
 - Outreach and Education Coordinator available prn
- Attendings
 - Dr. Donald Dafoe (Transplant Surgeon)
 - Dr. Hirohito Ichii (Transplant Surgeon)
 - Dr. Uttam Reddy (Transplant Nephrologist)
 - Dr. Ekamol Tantisattamo (Transplant Nephrologist)
 - Dr. Antoney Ferrey (Transplant Nephrologist)
- Transplant Resident (Green Team)
 - Pager: 714-506-8000

Thank you!



References/Resources

- United Network for Organ Sharing (UNOS): <https://unos.org/>
- Organ Procurement and Transplantation Network (OPTN): <https://optn.transplant.hrsa.gov/>
- Scientific Registry of Transplant Recipients (SRTR): <https://www.srtr.org/>
- Danovitch, G. M. (2017). *Handbook of kidney transplantation*. Philadelphia, PA: Wolters Kluwer Lippincott Williams & Wilkins.
- Cupples, S., Lerret, S., McCalmont, V., Ohler, L. (2016). International Transplant Nurses Society: Core Curriculum for Transplant Nurses ,2nd Edition. Lippincott Williams & Wilkins
- Social Determinants of Racial Disparities in CKD- Jenna M. Norton, Marva M. Moxey-Mims, Paul W. Eggers, Andrew S. Narva, Robert A. Star, Paul L. Kimmel and Griffin P. Rodgers JASN September 2016, 27 (9) 2576-2595; DOI: <https://doi.org/10.1681/ASN.2016010027>
- National Institute of Diabetes and Digestive and Kidney Diseases: <https://www.niddk.nih.gov/health-information/health-statistics/kidney-disease>
- Center for Disease Control and Prevention: <https://www.cdc.gov/diabetes/data/statistics-report/index.html>
- American Diabetes Association: <https://www.diabetes.org/resources/statistics/statistics-about-diabetes>
- UCI Transplant Resident Guide:
<https://healthuci.sharepoint.com/sites/transplant/Shared%20Documents/Resident%20pocket%20guide%20January%202019.pdf#search=transplant%20resident%20guide>
- UCI Transplant Inpatient Nursing Guide:
[https://healthuci.sharepoint.com/sites/transplant/Shared%20Documents/UC%20Irvine%20Kidney%20and%20Pancreas%20Transplant%20Inpatient%20Nursing%20Guide%20\(Updated%20201-2019\).pdf#search=transplant%20resident%20guide](https://healthuci.sharepoint.com/sites/transplant/Shared%20Documents/UC%20Irvine%20Kidney%20and%20Pancreas%20Transplant%20Inpatient%20Nursing%20Guide%20(Updated%20201-2019).pdf#search=transplant%20resident%20guide)

