TRANSPLANT SURGERY RESIDENT CURRICULUM

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OVERVIEW

This curriculum has been designed to provide a structured educational and training framework for the resident rotation on transplant surgery. The curriculum provides the residency directors with a basis for planning instruction for surgical residents rotating on the transplant service. It guides the resident in their course of study and defines key areas of knowledge necessary for understanding the basic concepts of transplantation surgery.

This curriculum contains both general and organ specific content. Residents need to understand the general content as well as the organ specific content for procedures in which they are training. It is recommend, but not required, that they be familiar with the general principles involved in other organ transplants.

The curriculum will contain discrete units, each containing 4 parts:

1. **Unit Objectives**: Broad summary topics which define key curriculum components
2. **Learner Objectives**: The specific knowledge to be acquired by the resident
3. **Content**: Outlines the study areas necessary to achieve the unit objectives; provides guidance to residents by identifying appropriate learning resources
4. **Clinical Skills**: Describes the clinical activities and technical tasks required of residents rotating on the transplant surgery service.

By the end of the transplant rotation, residents will be able to understand surgical and medical care of the transplant patient and identify areas necessary for continued learning related to the following areas of inquiry.

UNIT 1

PHARMACOLOGY AND IMMUNOSUPPRESSION

Unit Objectives

I. Explain the basic pharmacology (mechanisms of action, metabolism, adverse effects, potential interactions, dosing strategies, and target levels) for all immunosuppressive agents in current clinical use.

II. Outline potential complications and clinical and laboratory markers of over- and under-immunosuppression.

III. Define the donor and recipient factors which impact the use of immunosuppressive agents including the risk of rejection, infection, and malignancy.

IV. Identify the clinical and pathologic features of acute and chronic cellular and humoral rejection and implement appropriate pharmacologic therapy; identify short and long term ramifications of rejection episodes.

Learner Objectives

I. Explain the basic pharmacology (mechanisms of action, metabolism, adverse effects, potential interactions, dosing strategies, and target levels) for all immunosuppressive agents in current clinical use.

   A. Calcineurin-Inhibitors

      1. Explain the mechanism of action of CsA and tacrolimus.
      2. What is calcineurin?
      3. List commonly used drugs that interfere with CsA/tacrolimus
      4. metabolism by acting as substrates, inhibitors, and, inducers of the

5. cytochrome P450 enzyme CYP3A4.
6. List the most common side effects of CsA and tacrolimus?

B. Sirolimus

1. Explain the mechanism of action of this agent.
2. What is mTOR?
3. List the common side effects of this drug.

C. Antiproliferative Agents (mycophenolate mofetil, mycophenolic acid, and azathioprine)

1. Explain the mechanism of action of these agents.
2. What is a prodrug?
3. Describe the side effect profiles for these agents.

D. Monoclonal Antibodies (basiliximab, daclizumab, muromonab CD3)

1. Describe the difference between a depleting vs. non-depleting and a monoclonal vs. a polyclonal antibody preparation.
2. Explain the difference between a chimeric and a humanized monoclonal antibody.
3. Describe the mechanism of action, side effect profile, and appropriate dosing strategies for all 3 antibodies.

E. Polyclonal Antibodies (rabbit ATG, equine ATG)

1. Explain the basic steps in the preparation of xenogenic polyclonal anti-human lymphocyte sera. By what mechanisms do polyclonal antibodies deplete peripheral lymphocytes?

F. Steroids

1. Describe several possible mechanisms of action of prednisone.

2. Discuss the importance of steroids in the treatment of rejection and for maintenance immunotherapy.
3. Compare the advantages and disadvantages of steroid-free immunosuppressive protocols in renal, pancreas, and liver transplantation.
4. Describe the side effect profile and dosing strategy for prednisone.

II. Outline potential complications and clinical and laboratory markers of over- and under-immunosuppression.

A. Opportunistic Infections

1. List typical opportunistic infections associated with transplantation.
2. At what time points post-transplantation are opportunistic infections usually observed?
3. Describe the association between CMV infection, acute rejection, and long-term graft outcomes.

B. Malignancy

1. List the most common malignancies associated with transplantation.
2. At what percent greater risk of malignancy are transplant recipients compared with the general population?
3. Explain the association between EBV infection and PTLD.

III. Define the donor and recipient factors that impact the use of immunosuppressive agents, including the risk of rejection, infection, and malignancy.

A. Acute Rejection

1. Identify recipient groups that would generally be considered at high vs. low risk for acute rejection.
2. Describe induction protocols for management of recipients at high vs. low risk for acute rejection.

B. Infection/Malignancy

3. List the recipient groups at greater risk of infection post-transplantation.
4. List the recipient groups are at greater risk of PTLD.
5. Recommend strategies that could be used to reduce the risk of infection/PTLD for the above noted groups.

IV. Identify the clinical and pathologic features of acute and chronic cellular and antibody-mediated rejection and implement appropriate pharmacologic therapy; identify short and long-term ramifications of rejection episodes.

A. Describe clinical findings associated with antibody-mediated, cellular, and chronic rejection in renal, pancreas, and/or liver transplantation.

B. Describe management strategies for treatment of:

1. Antibody mediated rejection
2. Mild acute cellular rejection
3. Moderate to severe acute cellular rejection
4. Chronic rejection

C. Identify the early and late adverse events associated with the treatment of rejection episodes.

UNIT 2

ORGAN PROCUREMENT

Unit Objectives

I. Understand the moral, ethical and legal issues and steps involved in determining brain death.

II. Understand the moral, ethical and legal issues and steps involved in live organ donation.

III. Describe the basic assessment of the medical, laboratory, and anatomic characteristics of a potential organ donor (live or deceased), the quality of a donor organ, and its suitability for a given recipient.

IV. Outline in detail the procedure to safely recover abdominal organs from deceased donors, including those for donation after cardiac death (DCD).

V. Understand the recovery processes for living donor organs and describe the steps necessary to perform relevant organ specific recovery (liver, kidney, or pancreas).

VI. Outline the basic principles and limits of organ preservation and be familiar with organ preservation techniques, including pulsatile perfusion.

Learner Objectives

I. Understand the moral, ethical and legal issues and steps involved in determining brain death.

A. Be familiar with the historical development and evolution of brain death criteria in the United States.

B. Understand the moral, ethical and legal basis for declaration of brain death and the standard medical and radiologic criteria used to make this decision.

II. Understand the moral, ethical and legal issues and steps involved in live organ donation.

A. Be familiar with the historical development and evolution of live donor organ donation in the United States.

B. Understand the ethical, moral and legal basis for live donor organ donation.

III. Describe the basic assessment of medical, laboratory, and anatomic characteristics of a potential organ donor (live or deceased), the quality of a donor organ, and its suitability for a given recipient.

A. Understand the medical and surgical issues involved with determining the suitability of an organ from a deceased donor and its suitability for a given recipient.

B. Understand the psychosocial, medical, and surgical short-term and long-term issues involved with determining the suitability of an organ from a live donor and its suitability for a given recipient.

C. Understand the medical and surgical issues involved with determining the suitability of an organ from a donor after cardiac death (DCD) retrieval and an extended criteria donor (ECD) and its suitability for a given recipient.

IV. Outline in detail the procedure to safely recover abdominal organs from deceased donors, including those for donation after cardiac death (DCD).

A. Understand and be able to perform safe recovery of abdominal organs from deceased donors.

B. Understand and be able to perform safe recovery of abdominal organs from deceased donors who are DCD donors. (Basic fellowship is not assumed to include competence in DCD donor organ recovery.)

C. Be familiar with appropriate courtesy and etiquette to organ procurement personnel, operative staff and other organ procurement teams during single and multi-organ procurement.

V. Understand the recovery procedures for living donor organs and describe the steps necessary to perform relevant organ specific recovery (liver, kidney)

A. Understand the steps required to perform open and laparoscopic donor nephrectomy for the purposes of organ donation.

B. Understand the surgical procedure of live donor liver donation. (Basic fellowship is not assumed to include competence in live donor liver organ recovery.)

VI. Outline the basic principles and limits of organ preservation and be familiar with organ preservation techniques, including pulsatile perfusion.

A. Be familiar with basic principles of organ preservation and organ preservation fluids.

B. Understand the limits of organ preservation for each organ and the attendant risk of organ dysfunction over time.

C. Understand the basic principles of pulsatile kidney perfusion. (Basic fellowship is not assumed to include competence in pulsatile organ preservation.)

UNIT 3

KIDNEY TRANSPLANTATION

Unit Objectives

I. List the indications for kidney transplantation, explain the different disease processes resulting in end-stage renal disease, and describe the treatment options.

II. Outline the basic of principles of donor and recipient selection and deceased donor organ allocation.

III. Describe and perform living and deceased donor kidney transplant procedures;

IV. Explain the basic immunosuppressive strategies used in kidney transplantation, including induction and maintenance therapy.

V. Recognize and diagnose renal transplant rejection, identify basic pathologic findings of rejection, and describe treatment strategies for rejection.

VI. Describe appropriate long term follow-up and be able to identify and treat short and long term complications of kidney transplantation.

VII. Describe the short and long term outcomes of kidney transplantation.

VIII. Outline the basic principles of renal replacement therapy; identify indications for and surgical techniques necessary to place hemo- and peritoneal dialysis access.

Learner Objectives

I. List the indications for kidney transplantation, explain the different disease processes resulting in end-stage renal disease, and describe the treatment options for end-stage renal disease.

A. Understand the process that result in end stage kidney disease in adults and children including the pathophysiology, rate of progression, incidence of recurrent disease, and impact on transplantation for the following diseases:

   1. Hypertensive nephropathy
   2. Diabetic nephropathy
   3. Glomerulonephritis
   4. Reflux disease
   5. Autoimmune kidney disease (e.g. Lupus, Wegners)
   6. Inherited cystic diseases

B. Define the evaluation process for patients considering kidney transplantation including the following components

   1. Minimal pre-operative testing
   2. Cancer screening and period of waiting following diagnosis
   3. Cardiac evaluation
   4. Serologic evaluation and importance of viral testing (CMV, EBV, Hep B+C, HIV)

C. Understand when patients should be listed for transplant

   1. Minimal listing criteria (CrCl < 20)
   2. Pre-emptive vs. following the initiation of dialysis

D. Properly and completely consent the patient and family and explain the risks and benefits of renal transplantation compared with dialysis

1. Compare life expectancy on dialysis vs. transplant for a variety of patient populations
2. Understand basic peri- -operative complications.

II. Outline the basic principles of donor and recipient selection and deceased donor organ allocation.

A. Describe criteria used to assess the suitability of a deceased donor for organ transplant

1. Demographic factors (age, race, sex)
2. Cause of death
3. High risk behaviors
4. Presence of malignancy (CNS vs. others)
5. Viral status (Hep C, Hep B, HTLV-1)
6. Infection in donor
7. Hemodynamic status, vasopressor requirements
8. Length of cold ischemic time in all donors and warm ischemic time for DCDs
9. Anatomic considerations (multiple arteries, ureters, surgical damage)

B. Describe criteria used to assess the suitability of a living donor for organ transplant

1. Demographic factors (age, size, gender)

2. Evaluation of renal function including protein excretion
3. Presence of illnesses that may predispose the donor to renal insufficiency
4. Anatomic evaluation and considerations
    a. Multiple arteries
    b. Duplicated collecting systems
    c. Left vs. right kidney
5. Crossmatching
6. Psychological and psychosocial evaluation
7. Understand and perform the consent process for living donation including risks and benefits of laparoscopic and open nephrectomy, risk of short and long term complications, potential for transplant failure.
8. Appreciate the ethical issues involved in living donor transplantation, the role of independent donor advocates, and the potential for coercion.

III. Describe and perform living and deceased donor kidney transplant procedures;

A. Prepare the kidney for transplantation

1. Strategies to deal with common anatomic features including multiple arteries and veins

B. Understand possible surgical approaches for kidney transplant including extraperitoneal and intraperitoneal location

C. Describe the technique for isolating the iliac vessels and performing vascular anastomoses

D. Detail the procedure for implanting the ureter and importance of the blood supply to the ureter

    1. Creation of anti-reflux tunnel

    2. Indications for stent placement

E. Use of intra-operative adjunctive medications

F. Detail the post-operative care of renal transplant patients including:

    1. Fluid and electrolyte management

    2. Recognition and treatment of cardiac complications

G. Identify and treat surgical complications

    1. Bleeding

    2. Ureteral leak

    3. Lymphocoele

    4. Vascular thrombosis

    5. Wound complications

H. Describe and interpret relevant radiological evaluations

    1. Ultrasound

2. CT scanning

3. Lasix-renogram

4. Interventional diagnostics (angiogram, percutaneous nephrostogram)

I. Identify and manage delayed graft function

1. Determine the need for post-operative dialysis

2. When should a biopsy be performed?

IV. Explain the rationale for immunosuppressive strategies used in kidney transplantation, including induction therapy.

A. Induction immunosuppression

1. Understand the basics of induction immunosuppression

a. Steroids

b. Antibody preparations

B. Determine appropriate maintenance immunosuppressive regimen

1. Rationale for choice of CNI, anti-proliferative, and/or steroids

2. Appreciate issues of timing (e.g. delayed CNI for DGF)

C. Counsel patients regarding the need for compliance, potential side effects and important drug interactions, and strategies to minimize side effects.

V. Recognize and diagnose renal transplant rejection including performing diagnostic biopsy and interpreting basic pathological findings

A. Participate in the care of post-transplant patients

B. Review and evaluate pertinent laboratory data to identify potential for rejection or other etiologies of graft dysfunction

C. Determine the need for a percutaneous biopsy, ultrasound examination, or other diagnostic procedure

D. Renal biopsy

1. Provide appropriate consent discussion for patients

2. Utilize ultrasound for location of graft

3. Perform needle biopsy with the assistance of the fellow or attending

4. Send specimen for appropriate diagnostic studies (H and E evaluation, C4D staining)

5. In cooperation with renal pathologist, review biopsy results and identify the basic pathologic features of rejection of renal allografts

E. Describe the treatment approaches for acute allograft rejection

1. Understand the difference in treatment for cellular and humoral rejection

F. Understand the impact on long term outcome from acute rejection episodes

VI. Describe appropriate long term follow-up and be able to identify and treat short and long term complications of kidney transplantation.

A. Participate in and understand the process of long term follow-up of transplant patients

B. Appreciate the health maintenance needs of transplant patients

C. Describe techniques to preserve long term graft function

D. Understand the impact of cardiac disease on the long term outcome of renal transplant patients

VII. Describe the short and long term outcomes of kidney transplantation.

A. Appreciate short and long term outcome of kidney recipients

VIII. Outline the basic principles of renal replacement therapy; identify indications for and surgical techniques necessary to place hemo- and peritoneal dialysis access.

A. Describe the pre-operative evaluation of patients considering vascular access

B. Independently consent patients for vascular access and explain the risks, benefits, and options

C. Perform vascular access procedures including

1. Arm fistulas

2. Arm grafts

3. Place percutaneous lines for dialysis

D. Describe techniques for complicated access (leg fistula, chest grafts, leg grafts).

E. Identify and design treatment strategies for complications of access procedures

    1. Stenosis/thrombosis

    2. Steal syndrome

    3. Poor maturation of fistula

F. Evaluate patients for peritoneal catheter placement

    1. Describe surgical technique

    2. Determine need for surgical removal in case of infection, malfunction

UNIT 4

LIVER TRANSPLANTATION

Unit Objectives

I. Outline the basic principles of liver transplantation, donor and recipient selection and donor allocation.

II. Describe the types of immunosuppressive therapy utilized in liver transplantation.

III. List the different disease processes which may require liver transplantation; understand the management of complications of liver disease including end stage liver disease and the care of patients with fulminant hepatic failure.

IV. Describe the workup needed to diagnose liver transplant rejection.

V. Describe the operative steps necessary involved in performing liver allograft recovery from deceased donors and deceased donor liver transplant.

VI. Diagnose and implement treatment approaches for both short and long term medical and surgical complications following liver transplantation

Learner Objectives

I. Outline the basic principles of liver transplantation, donor and recipient selection and donor allocation. Upon completion of this unit the resident will:

   A. Understand the basics of evaluation and management of prospective liver transplant recipients

   B. Understand the basics of evaluation and management of prospective liver transplant donors

1. Deceased donor
2. Live donor
3. Pediatric donor including split-liver grafts

C. Understand the UNOS liver donor allocation system (MELD score)

II. Describe the types of immunosuppressive therapy utilized in liver transplantation. Upon completion of this unit the resident will:

A. Be familiar with the following immunosuppressive agents and their use in multi-drug regimens:

1. Cyclosporine
2. Tacrolimus
3. Induction therapy

III. List the different disease processes which may require liver transplantation; understand the management of complications of liver disease including end stage liver disease and the care of patients with fulminant hepatic failure. Upon completion of this unit the resident will:

A. Be familiar with the common indications for liver transplantation including:

1. End-stage liver disease
    a. Alcoholic liver disease
    b. Viral hepatitis (HBV, HCV)

c. Autoimmune hepatitis

d. Cholestatic liver disease (PBC, PSC)

e. Non-alcoholic steatohepatitis (NASH)

2. Metabolic disease

a. Alpha 1 antitrypsin disease

b. Hemochromatosis

c. Amyloidosis

d. Oxaluria

e. Other

3. Acquired disease

a. Budd-Chiari syndrome

b. Pulmonary disease (Portopulmonary hypertension/hepatopulmonary syndrome)

4. Neoplasia

a. Hepatocellular carcinoma

5. Acute fulminant hepatic failure

B. Understand and describe the management of common complications of chronic end-stage liver disease:

1. Portal hypertension

a. Ascites

b. Variceal bleeding

c. Hepatorenal syndrome

d. Subacute bacterial peritonitis

e. Chronic hepatic encephalopathy

2. Coagulopathy

C. Understand and describe the management of common complications of acute hepatic failure:

1. Acute hepatic encephalopathy

2. Cerebral edema

3. Coagulopathy

4. Other

IV. Describe the workup needed to diagnose liver transplant rejection. Upon completion of this unit the resident will:

A. Be familiar with the clinical and laboratory presentation of acute rejection of the liver allograft

B. Be familiar with the technique of percutaneous liver biopsy including management of complications

V. Describe the operative steps necessary involved in performing liver allograft recovery from deceased donors and deceased donor liver transplant. Upon completion of this unit the resident will:

A. Be familiar with the basic technique of multi-organ and liver allograft alone, and deceased donor recovery for routine recipients

VI. Diagnose and implement treatment approaches for both short and long term medical and surgical complications following liver transplantation. Upon completion of this unit the resident will:

A. Understand the short-term medical and surgical complications of liver transplantation:

1. Bleeding
2. Infection
3. Primary or delayed liver allograft function
4. Multi-organ failure including heart, lung, kidney, other
5. Neurological
6. Other

B. Understand the long-term medical and surgical complications of liver transplantation:

1. Recurrent disease
2. Renal insufficiency

3. Infection
4. Malignancy
5. Endocrine
6. Other

UNIT 5

HEPATOBILIARY SURGERY

Unit Objectives

I. Understand and describe the surgical anatomy of the liver and biliary tract.

II. Understand the physiology and function of the liver and biliary tract

III. Understand the use of radiologic imaging of the liver and biliary tree

IV. Describe the preoperative assessment of hepatobiliary patients

V. Understand the indications and contraindications for liver biopsy

VI. Understand the pathophysiology and management of common hepatobiliary diseases

VII. Describe the postoperative management of a patient undergoing hepatobiliary surgery

VIII. Gain experience with specific operative skills necessary in hepatobiliary surgery

IX. Residents will have an opportunity to be exposed to the following operative procedures

Learner Objectives

I. Understand and describe the surgical anatomy of the liver and biliary tract.

Residents should become familiar with:

A. Arterial and venous anatomy

B. Anatomy of the biliary tract

C. Anomalies in the blood vessels and biliary tract

D. Concept of segmental anatomy of the liver

II. Understand the physiology and function of the liver and biliary tract

III. Understand the use of radiologic imaging of the liver and biliary tree

- A. Ultrasound
- B. Computed tomography
- C. Magnetic resonance imaging
- D. Endoscopic retrograde cholangiography/pancreatography
- E. Percutaneous transhepatic cholangiography (PTC)

IV. Describe the preoperative assessment of hepatobiliary patients

- A. Assessing candidacy for surgery
- B. Assessment of liver function
- C. Nutritional assessment

V. Understand the indications and contraindications for liver biopsy

VI. Understand the pathophysiology and management of common hepatobiliary diseases

- A. Gallstones disease
  1. Cholelithiasis
  2. Choledocholithiasis
  3. Gallstone pancreatitis

4. Operative management (CBD exploration, transcystic exploration, lap vs. open, etc.)
5. Non-operative management

B. Diagnosis and management of cholecystectomy related complications

1. Bile leak
2. Retained CBD stone
3. Bleeding
4. CBD injury
5. Hepatic artery injury

C. Understand the pathophysiology, diagnosis, and treatment options for malignant liver and biliary lesions

1. Hepatocellular carcinoma
2. Cholangiocarcinoma (Intrahepatic and extrahepatic)
3. Gallbladder cancer
4. Periampullary cancer
5. Metastatic disease

D. Understand the pathophysiology, diagnosis, and treatment options for benign liver and biliary diseases

1. Cystic lesions (liver and biliary tree)
2. Focal nodular hyperplasia
3. Hemangiomas
4. Adenomas
5. Gallbladder polyps
6. Primary biliary cirrhosis

7. Primary sclerosing cholangitis

E. Biliary Stricture/Obstruction:

1. Etiology
    a. Benign
    b. Malignant
2. Diagnostic modalities used to differentiate benign vs. malignant disease
3. Operative and Non-operative management

F. Liver and biliary infection

1. Cholangitis
2. Management of liver infections
    i. Pyogenic liver abscess
    ii. Amebiasis
    iii. Hydatid disease
    iv. Recurrent pyogenic cholangitis

G. Be able to understand and describe the management of liver injury

1. Indications for surgery
2. Non-operative management
3. Hemobilia
4. Describe the method of total hepatic vascular isolation

H. Cirrhosis and portal hypertension

1. Etiology (viral, alcohol, autoimmune, etc.)
2. Diagnosis
3. Management of ascites
4. Medical management of bleeding varices

5. Surgical management of related complications (bleeding, leaking ascites, etc.)
6. Indications and role of surgical shunts (central, non-selective, selective, etc.)
7. Indications for TIPS
8. Budd-Chiari syndrome and veno-occlusive disease

VII. Describe the postoperative management of a patient undergoing hepatobiliary surgery

A. Fluids and electrolytes

B. Assessment of liver function

C. Be familiar with hepatobiliary specific complications and their management

1. Bile leak
2. Portal vein or hepatic artery thrombosis
3. Post-operative liver failure

VIII. Gain experience with specific operative skills necessary in hepatobiliary surgery

A. Mobilization of the liver

B. Pringle maneuver

C. Dissection of the porta hepatis

D. Understand how to assess for aberrant arterial and biliary anatomy

E. Exposure of the retrohepatic vena cava

F. Liver parenchymal transection and control of bleeding from the liver

IX. Residents will have an opportunity to be exposed to the following operative procedures

A. Radical cholecystectomy

B. Biliary bypass procedures for obstruction or stricture

C. Hepaticojejunostomy

D. Hepatic resection for metastatic disease

E. Liver resection

1. Lobar resection

2. Segmental resection

F. Non-resectional techniques for treating hepatic tumors

1. Radio frequency ablation

2. Alcohol ablation

3. Hepatic artery chemo-infusion

G. Pancreatic Surgery

1. Pancreaticoduodenectomy (Whipple Procedure)

2. Distal pancreatectomy

H. Bile duct resection

I. Surgical treatment of portal hypertension

1. Distal splenorenal shunt

2. Portacaval shunt

J. Non-shunt procedures for treating portal hypertension

1. Devascularization-Sugiura procedure