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Acknowledgements

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ASTS Curriculum: Policies and Allocation

1. Introduction

- a. Purpose of Organ Allocation Policies
- b. Ethical Principles in Organ Allocation
- c. Overview of Global and National Frameworks

2. Organ Donation Systems

- a. Types of Organ Donation
 - i. Living Donation
 - ii. Deceased Donation
- b. Opt-in vs. Opt-out Donation Systems
 - i. US
 - ii. International Systems
- c. Public Awareness and Education Campaigns

3. Governing and Regulatory Bodies of Organ Allocation in the US

- a. The role of federal players: CMS, HRSA, Congress
 - i. OPTN is a contract of HRSA - OPTN Member obligations (OPOs and transplant programs), new structure and modernization
 - ii. Regulation and Compliance – the role of MPSC and CMS
- b. The role of SRTR
 - i. Public reporting – PSRs, OPO reports, Data interpretation
 - ii. Analyses supporting OPTN activities (allocation policy, quality monitoring)

4. Candidate Registration and Removal

- a. Medical Criteria
 - i. Blood Type Matching
 - ii. Tissue Typing (HLA Matching)
 - iii. Urgency and Disease Severity
- b. Non-Medical Factors
 - i. Geographic Location and Distance
 - ii. Waiting Time on the Transplant List
 - iii. Age and Life Expectancy
- c. Consent process for evaluation and listing

5. Allocation Policies by Organ Type

- a. Overview/Priorities
 - i. Urgency-Based Systems
 - ii. Point-Based Systems
 - iii. First-Come, First-Served Models
 - iv. Special Considerations (e.g., Pediatrics, Re-transplantation)
 - v. Continuous distribution
- b. Liver
- c. Kidney/Pancreas
- d. Intestine
- e. Heart

- f. Lung
 - g. Multi-Organ
- 6. Organ Procurement**
 - a. Brain Death
 - b. Donors after Cardiac Death
 - c. NRP
 - d. Organ and Extra Vessel Packaging, Labeling, Shipping, and Storage
 - e. Identification and Tracking of Transmissible Diseases
- 7. Ethical and Legal Issues**
 - a. Equity vs. Utility in Allocation
 - b. Handling Organ Shortages
 - c. Financial and Socioeconomic Barriers
 - d. Legal Issues and Disputes
 - e. Black Markets and Illegal Trade Prevention
- 8. International Policy Comparisons**
 - a. United States (OPTN)
 - b. European Union Policies
 - c. Systems in Asia and the Middle East
 - d. Developing Nations and Access Challenges
- 9. Future Directions**
 - a. Challenges in Organ Allocation
 - b. Opportunities for Policy Improvement
 - c. Balancing Ethics and Efficiency

1. Immunobiology of Transplant

- a. Foundational Immunobiology
 - i. Adaptive Immunity
 - ii. Specific Immunity
 - iii. Complement activation
 - iv. Antigen presentation
 - v. Major histocompatibility complex
 - 1. Type I/Type II
- b. Tissue Typing, Crossmatching
 - i. Tissue Typing
 - ii. Mechanisms and limitations of various crossmatching techniques
 - iii. PRA
 - iv. Desensitization strategies
 - 1. Highly sensitized patients
 - 2. ABO incompatible
 - 3. Crossmatch Positive
- c. Rejection
 - i. T Cell Mediated Rejection
 - 1. Signs, symptoms
 - 2. Pathology findings
 - 3. Treatment
 - ii. Antibody Mediated Rejection
 - 1. Signs, symptoms
 - 2. Pathology findings
 - 3. Treatment
 - 4. Tolerance
 - 5. Acute versus chronic rejection
- d. Tolerance

2. Pharmacology

- a. Immunosuppression
 - i. Drugs Mechanisms of Action, Side Effects
 - 1. Signal 1 Blockers: Calcineurin Inhibitors
 - a. Drugs
 - i. Tacrolimus
 - ii. Cyclosporine
 - b. Side Effects
 - i. Vasoconstriction: Renal effects
 - ii. Neuro Toxicity
 - iii. Thrombotic Microangiopathy
 - iv. Metabolic Effects: Glucose, HL, HTN
 - v. Hair patterns
 - vi. Gingival Enlargement
 - 2. Signal 2 Blockers: Co-Stim Blockers

- a. Drugs
 - i. Belatacept
 - b. Side Effects:
 - i. Post-transplant Proliferative Disorder (PTLD)
 - 3. Signal 3 Blockers
 - a. Drugs:
 - i. IL-2 receptor antagonists
 - ii. mTOR inhibitors
 - iii. Antimetabolite agents
 - b. Side Effects
 - i. Severe Acute hypersensitivity (Basiliximab)
 - ii. Wound Healing (mTOR)
 - iii. GI Upset, Bone Marrow Suppression (Mycophenolic Acid)
 - 4. Lymphocyte Depleting Agents
 - a. Drugs
 - i. Alemtuzumab
 - ii. Anti-thymocyte Globulin
 - b. Side Effects
 - i. Infusion reactions
 - ii. Leukopenia and Thrombocytopenia
 - 5. Corticosteroids
 - ii. Clinical Uses of Immunosuppression
 - 1. Induction
 - 2. Maintenance
 - 3. Treatment of Rejection
 - a. T Cell Mediated Rejection
 - i. Signs, symptoms
 - ii. Pathology findings
 - iii. Treatment
 - b. Antibody Mediated Rejection
 - i. Signs, symptoms
 - ii. Pathology findings
 - iii. Treatment
 - iii. General Effects of Immunosuppression
 - 1. Cancers
 - 2. Infections
 - a. Bacterial
 - b. Viral
 - c. Fungal
- b. Medications Used for Post Transplant Prophylaxis
 - i. Infection prophylaxis
 - ii. Gastrointestinal prophylaxis
 - iii. Anticoagulation

3. Infectious Disease in the Transplant Patient

- a. Pre transplant considerations
 - i. Exposure histories (travel, animal, environmental)
 - ii. Immunizations
 - 1. Understand importance of live versus attenuated with relation to transplant status and timing
 - iii. Active infection
- b. Post Transplant considerations
 - i. Timeline/Phases of post-transplant infections
 - 1. Early (1 month)
 - 2. Mid (1-12 months)
 - 3. Late (>12 months)
 - ii. Epidemiology of Infection
 - 1. Donor-derived
 - 2. Recipient-derived
 - 3. Community-derived
 - 4. Nosocomial
 - iii. Opportunistic Infections
 - 1. Viral
 - a. CMV
 - i. Pathogenesis
 - ii. Prophylaxis
 - 1. Risk stratification (donor/recipient serostatus)
 - iii. Manifestations
 - iv. Treatment
 - b. Herpes Viruses
 - i. Pathogenesis, Manifestations, Diagnosis
 - ii. Management of Epstein Barr Virus (EBV) and PTLD
 - c. Polyoma Viruses
 - i. Manifestations, Diagnosis, Management
 - 1. BK, JC, HPV, HPV, Adenovirus
 - 2. Specific points:
 - a. Progressive Multifocal Leukoencephalopathy (PML): JC Virus
 - b. Ureteral stricture: BK
 - 2. Fungal Infections
 - a. Understand pathogenesis, manifestations, diagnosis, and treatment for the more commonly occurring fungal infections
 - i. Candida
 - ii. Aspergillus
 - iii. C. Neoformans
 - iv. Endemic mycosis
 - v. P. Jirovecii
 - b. Fungal Prophylaxis
 - i. Candida
 - ii. P. Jirovecii

3. Parasites

a. Strongyloides

c. Donor-Derived Infections

i. Expected transmissions

1. Cytomegalovirus (CMV), Epstein Barr Virus (EBV)

ii. Latent

1. Tuberculosis, Toxoplasmosis, Strongyloides

iii. Active infections

1. Diagnosis, Treatment
2. Infectious contraindications to transplant

d. Vaccines

i. Pre-transplant

1. Immune status
2. Recommended Vaccines
3. Timing of Vaccination.

ii. Post transplant

1. Vaccine Type

- a. Live
- b. Inactivated

ASTS Curriculum Donor Unit

1. Donor Evaluation

- a. Legislation surrounding donation
 - i. The Uniform Determination of Death Act
- b. Donation after Neurologic Determination of Death
 - i. Confirmatory Tests of Brain Death
 - ii. Bioelectrical Activity Testing
 - iii. Evoked Cerebral Potentials
 - iv. Cerebral Circulatory Testing
- c. Deceased after Cardiac Death (DCD) Definitions
 - i. Controlled versus Uncontrolled
 - ii. Modified Maastricht classification of DCD donors (Paris 2013): I-IV
 - iii. Agonal
 - iv. Warm Ischemia Time
 - v. Normothermic Regional perfusion
- d. Outcomes of DCD recovered organs
 - i. Kidney: Graft survival, Delayed Graft Function(DGF), Primary Graft Non-Function (PNF)
 - ii. Liver: Graft survival, Non-anastomotic biliary stricture/ischemic cholangiopathy, Primary Non-Function
 - iii. Pancreas: graft survival, thrombosis, Primary Non-Function

2. Donor Management: Physiology and Testing

- a. Physiology of Brain Death
 - i. Hypothalamic-Pituitary Axis Dysfunction
 - ii. Dysfunction of vascular tone
 - iii. Arrhythmia
 - iv. Electrolyte disturbance
 - v. Metabolic dysfunction/dysregulation

3. Donor Assessment

- a. Organ specific tools for assessment of deceased donor organs
 - i. Kidney
 - 1. Kidney Donor Profile Index (KDPI)
 - ii. Liver
 - iii. Pancreas
- b. Donor Medical and Behavioral History
 - i. Malignancy
 - ii. Hypertension
 - iii. Diabetes

- iv. Alcohol use disorder
 - v. Hepatitis
 - vi. Genetic disease
 - vii. Hypercoagulability
 - viii. Steatosis
- c. Donor status considerations
 - i. Trauma
 - ii. Shock and vasopressor support
 - iii. Acute Kidney Injury
 - iv. Hemodilution
- d. Infectious Disease Testing
 - i. HIV Screening
 - 1. Hope Act
 - ii. Viral Testing
 - 1. Nucleic Acid Testing (NAT)
 - 2. Antibody Testing
 - iii. Specific infectious disease screening
 - 1. Hepatitis B
 - a. Core and Surface Antigen Testing
 - 2. Hepatitis C
 - a. Antibody and NAT Testing
 - 3. Cytomegalo Virus (CMV)
 - 4. Epstein Barr Virus (EBV)
 - 5. Syphilis
 - 6. Toxoplasma
 - 7. Strongyloides
 - 8. West Nile Virus
 - 9. COVID

4. Donor Perioperative Recovery Steps

- a. Pre recovery verification
 - i. Documentation of Death
 - ii. Donor Identification and OPTN ID
 - iii. Donor Blood type
 - iv. Donor Authorization
- b. Multiple teams logistics
 - i. Sharing of vessels
 - ii. Timing/delays logistics

5. Organ procurement operation details

- a. Anatomy
 - i. Anatomy of the porta (normal and variants)

1. Portal vein
 2. Hepatic artery
 3. Bile duct, gallbladder
 - ii. Anatomy of the abdominal aorta and iliac vessels
 - iii. Anatomy of the retroperitoneum and kidneys (normal and variants)
 1. Renal artery
 2. Renal vein
 3. Ureter
 4. Kidney (horseshoe, en bloc)
 - iv. Chest wall anatomy
- b. Operative components: Cerebral Death Donor
- i. Incision, opening of chest
 - ii. Isolation of vasculature for cannulation
 - iii. Heparinization and Cannulation
 - iv. Warm Dissection
 - v. Cross clamp, venting, cold perfusion flush, cooling
 - vi. Cold dissection
 - vii. Procurement of Additional Vessels
- c. Organ procurement detailed steps
- i. Deceased donor nephrectomy
 - ii. Deceased donor hepatectomy
 - iii. Deceased donor pancreas procurement
 - iv. Deceased donor technical variant grafts
 - v. Deceased donor intestine/multivisceral procurement
- d. Rapid recovery operation
- i. Role of the transplant surgeon
 - ii. Operative components
 1. Administration of Heparin
 2. Withdrawal of Life sustaining Measures; initiation of palliative care
 3. Determination of circulatory arrest
 4. Observation period
 5. Pronouncement of Death
 - iii. Operative steps: DCD/Super Rapid Recovery
 1. Incision, opening of chest
 2. Isolation of vasculature for cannulation
 3. Cold perfusion flush, venting, cross clamp, cooling
 4. Cold dissection
- e. Normothermic Regional Perfusion
- i. Role of the transplant surgeon
 - ii. Role of the perfusion team
 - iii. Approaches

1. Thoracic
2. Abdominal
- iv. Regulatory Guidance regarding exclusion of cerebral circulation
- v. Interpretation of NRP flowsheet and data

- f. Intraoperative Assessment of Organs
 - i. Gross inspection in warm
 - ii. Biopsy evaluation
 - iii. Post flush inspection
 - iv. Anatomy Description and Assessment

6. Circulatory Death Donors: Organ Specific Considerations

- a. Kidney
 - i. Delayed graft function
 - ii. Long term graft and recipient outcomes
- b. Liver
 - i. Ischemia reperfusion injury
 - ii. Early Allograft Dysfunction
 - iii. Ischemic cholangiopathy
 - iv. Long term graft and recipient outcomes
- c. Pancreas

7. Organ Preservation

- a. General Principles
 - i. Cold preservation
 - ii. Rewarming Injury
 - iii. Reperfusion injury
- b. Preservation Solutions
 - i. Components and Functions
 - ii. Commonly Used Solutions"
 1. University of Wisconsin Solution
 2. Histidine-Tyrosine-Ketoglutarate (HTK)
 3. Celsior

ASTS Curriculum Kidney Transplant

1. Anatomy, Physiology and Testing of the Kidney

- a. Relevant Anatomy
 - i. Abdominal wall
 - ii. Pelvis and Retroperitoneum
 - iii. Genitourinary
 - 1. Male and female external genitalia
 - 2. Urethra
 - 3. Bladder
 - iv. Lymphatic drainage of pelvis
 - v. Innervation of pelvis viscera and genitourinary system
- b. Physiology of the kidney
 - i. Components of the Nephron
 - ii. General functions of the kidney
 - 1. Maintenance of body fluids
 - 2. Renal clearance, renal blood flow, Glomerular filtration rate (GFR)
 - 3. Reabsorption and secretion
 - 4. Regulation of sodium, potassium, urea, phosphate, calcium, magnesium
 - 5. Concentration and Dilution of Urine
 - 6. Renal hormones
 - 7. Acid-Base Balance
 - 8. Diuretics
- c. Clinical hematologic & biochemical tests relevant to the kidney and their indications and interpretation
 - i. Hematologic and biochemical assessment
 - 1. Renal clearance
 - a) GFR
 - b) Creatinine Clearance (serum, 24 hour urine)
 - 2. Urinalysis
 - 3. Serum hormone assessment
 - ii. Histologic Assessment
 - 1. Biopsy assessment
- d. Kidney Imaging
 - i. Techniques and Interpretation
 - 1. Ultrasound & Doppler, Computerized Tomography (CT) Scans, Magnetic Resonance Imaging (MRI) Scans
 - 2. Nuclear tests: MAG 3
- e. Urologic testing
 - i. Nephrostogram
 - ii. Cystourethrogram (VCUG)
 - iii. Urodynamic testing and interpretation
 - iv. Cystoscopy

2. Urologic pathology and impact on kidney transplantation

- a. Vesicoureteral reflux
- b. Abnormal bladder compliance
- c. Urinary infection
- d. Urinary incontinence
- e. Voiding dysfunction
 - i. Male (Benign Prostatic Hypertrophy (BPH))
 - ii. Female
 - 1. Anatomic (organ prolapse, incontinence surgery)
 - 2. Functional (detrusor underactivity)

3. Immunologic considerations

- a. Human Leukocyte Antigens (HLA)
- b. Percent Reactive Antibody (PRA)
- c. Implications of sensitization on allocation
- d. Mechanisms of sensitization

4. Approaches to management of highly sensitized recipients

5. Components of the Kidney Transplant Evaluation

- a. Consultations
 - i. Nephrology Evaluation
 - ii. Urologic Evaluation
 - iii. Surgical Evaluation
 - iv. Cardiopulmonary Evaluation
 - v. Anesthesia Evaluation
 - vi. Dental Assessment
 - vii. Psychiatry, Psychology, Neurocognitive/neurodevelopmental assessment
 - viii. Nutrition Evaluation
 - ix. Social Work Evaluation (patient and family; identify family/pediatric resources, medical foster care)
- b. Testing
 - i. Laboratory testing (medical and regulatory)
 - ii. Cross sectional imaging
 - iii. Dynamic Urologic testing
 - 1. Voiding cystourethrogram (VCUG)
 - 2. Urodynamics
- c. Combined organ transplant
 - i. Simultaneous Liver Kidney
 - ii. Heart Kidney

6. Contraindications to kidney Transplantation

7. Listing for Transplantation

8. Donor Recipient Matching

- a. Donor and Graft Evaluation
 - i. Deceased donor
 - ii. Living donor

9. Principles of Kidney Preservation

- a. Mechanisms of Injury
 - i. Pre preservation
 - ii. Cold preservation
 - iii. Rewarming Injury
 - iv. Reperfusion Injury
- b. Components of Perfusion
 - i. Exsanguination
 - ii. Hypothermia
 - iii. Preservation Solutions
- c. Perfusion Strategies
 - i. Static Cold Storage
 - ii. Hypothermic pulsatile machine perfusion
 - iii. Normothermic machine perfusion

10. Kidney transplant techniques

- a. Implantation
 - i. Recipient Vascular considerations
 - ii. Ureteral drainage
- b. Native nephrectomy
 - i. Polyuria
 - ii. Refractory hypertension
 - iii. Infectious risk
 - iv. Space
- c. Genitourinary considerations
- d. Staged versus simultaneous procedures
- e. Special considerations:
 - i. Peds en bloc
 - ii. Dual kidney
 - iii. History of previous transplant
 - iv. Transplant nephrectomy

10. Kidney Transplant Anesthesia considerations

- a. Venous and arterial access
- b. Blood volume and resuscitation
- c. Blood pressure management and augmentation
- d. Pain control

11. Immunosuppression

- a. Induction and Maintenance immunosuppression
- b. Desensitization
- c. Rejection
 - i. Acute and Chronic
 - ii. T-Cell and B-Cell mediated
 - iii. Incidence
 - iv. Surveillance
 - v. Treatment

- vi. Pathological findings of rejection

12. **Post operative management**

- a. Early posttransplant issues
 - i. Delayed Graft Function
 - 1. Contributing factors/risk factors
 - 2. Patient management
 - ii. Primary Non-Function
 - iii. Technical Complications (diagnosis and management)
 - 1. Ureteral
 - a) Leak
 - b) Stenosis
 - 2. Vascular complications
 - a) Bleed
 - b) Thrombosis
 - c) Stenosis
 - iv. Cardiac
 - v. Infectious
- b. Late complications
 - i. PTLT
 - ii. CMV, BK
 - iii. Ureteral complications
 - iv. Transplant renal artery stenosis
 - v. Chronic allograft nephropathy
 - vi. Recurrence of native disease
- c. Graft loss
 - i. Early
 - ii. Late
 - iii. Transplant nephrectomy

13. **Living Kidney Donation**

- a. Advantages of living donor kidney transplant
- b. Donor work-up
 - i. Evaluation of potential living donor
 - 1. Measuring creatinine clearance
 - 2. Imaging
 - 3. Special considerations
 - a. Stones
 - b. Genetic testing
 - i. APOL1
 - c. Contraindications
- c. Operative approach
- d. Paired exchange
 - i. Indications
- e. Donor Management
 - i. Early Post op complications
 - ii. Long-term consequences/implications of kidney donation for the donor
 - iii. Post donation follow up

ASTS Curriculum: Pancreas Transplant

1. Anatomy, Physiology and Testing of the Pancreas Transplant

- a. Anatomy of the pancreas and the relationship with adjacent & surrounding structures
- b. Anatomy of the pancreas
 - i. Segments
 - ii. Anomalies
 - iii. Histology of the normal pancreas
- c. Anatomy of the porta
 - i. Portal vein, hepatic artery
 - ii. Bile duct
 - iii. Variants of normal and anomalies (replaced right hepatic artery)
- d. Physiology of the pancreas
 - i. Exocrine
 - ii. Endocrine
- e. Biochemical tests relevant to the pancreas and their interpretation
 - i. Pancreas inflammatory enzymes
 - ii. Measures of pancreas function

2. Pancreas Disease in Adults

- a. Endocrine dysfunction - Diabetes
 - i. Causes of type 1 and 2 Diabetes
 - ii. Metabolic fatty pancreas disease
 - iii. Autoimmune pancreas disease
- b. Exocrine dysfunction – Malabsorption
 - i. Pancreatitis
- c. Physiology of End Stage Pancreas Disease
 - i. Neurologic
 - ii. Nutrition
- d. Management of Complications of End Stage Pancreas Disease

3. Pancreas Transplant Recipient Evaluation

- a. Indications for Pancreas Transplant
 - i. Chronic Pancreas Disease/Complications
 - ii. Hypoglycemic unawareness
 - iii. Evaluation of kidney function (SPK, PAK, PTA)
- b. Components of the Pancreas Transplant Evaluation
 - i. Consultations
 - 1. Endocrine Evaluation
 - 2. Surgical Evaluation
 - 3. Cardiac Evaluation
 - 4. Anesthesia Evaluation
 - 5. Dental Assessment
 - 6. Psychiatry, Psychology, Mental Health and/or AODA
 - 7. Nutrition Evaluation
 - 8. Social Work Evaluation
 - ii. Testing
 - 1. Laboratory testing (medical and regulatory)
 - 2. Cross sectional imaging

- 3. General health screening (Colonoscopy, Pap smear, Mammogram)
 - 4. Frailty screening
 - 5. Bone disease (when indicated)
 - iii. Financial and insurance screening and counselling
 - iv. Combined organ transplant
 - 1. Simultaneous Pancreas Kidney
- c. Contraindications to Pancreas Transplantation
 - i. Severe cardiac or pulmonary disease
 - ii. Malignancy
 - iii. Uncontrolled sepsis
 - iv. Lack of potential social support system or ability to adhere to post transplant requirements

4. Pancreas Donor Selection

- a. Donor Recipient Matching
- b. Donor and Graft Evaluation
- c. Donor History and conditions
 - i. Malignancy
 - ii. Pancreas disease or pancreatitis
 - iii. Infectious Disease
 - iv. Shock/hemodynamic Instability
 - v. Trauma
 - vi. Social risk factors
- d. Pre-Operative Donor Imaging
 - i. Relevant Anatomy and common vascular variants
- e. Organ Inspection
 - i. Gross inspection
 - ii. Fat
 - iii. Texture
 - iv. Edema
 - v. Trauma
 - vi. Duodenal integrity
- f. Managing consent and disclosure of donor considerations and risk
- g. Deceased Donor
 - i. Special considerations in pancreas donor
 - ii. Operative planning with multiple teams
 - 1. Anatomic variants
 - a. Replaced right
 - b. Portal vein transection line
 - 2. Flush
 - a. Type
 - b. Volume
 - c. Location
 - iii. Donation after Cardiac Death - implications in pancreas transplantation
 - iv. Donation after Brain Death

5. Principles of Pancreas Preservation

- a. Mechanisms of Injury
 - i. Pre-preservation

- ii. Cold Preservation
 - iii. Rewarming Injury
 - iv. Reperfusion Injury
- b. Novel Perfusion Strategies
 - i. Normothermic regional perfusion

6. The Pancreas Transplant Operation

- a. Pancreas Transplant Anesthesia considerations
- b. Pathophysiology of pancreas disease
 - i. General considerations (SVR, CO)
 - ii. Systemic conditions: DM, glucose monitoring
 - iii. Communication regarding administration of insulin
 - iv. Electrolyte abnormalities
 - v. Acid/Base management
- c. Pancreas Transplant Operation
- d. Backtable preparation of the pancreas
 - i. Graft preparation and splenectomy
 - ii. Vascular reconstruction
 - 1. Arterial
 - 2. Portal
- e. Recipient Operation
 - i. Sequence of operation (in SPK)
 - ii. Exposure
 - iii. Implant
 - 1. Implantation considerations
 - i. Location
 - 1. Pancreas Alone
 - 2. Simultaneous
 - ii. Drainage
 - 1. Exocrine
 - a. Enteric
 - i. Roux
 - ii. DuodenoJ
 - iii. Duodeno-ostomy
 - b. Bladder
 - c. Benefits/Pitfalls
 - 2. Endocrine
 - a. Systemic
 - b. Portal
 - c. Benefits/Pitfalls
 - iii. Pancreas Orientation
 - 1. Head up/down
 - iv. Anticoagulation
 - 1. Intraop
 - 2. Postop

7. Management of Post Pancreas Transplant Patients

- a. Evaluation of early allograft function
 - i. Evaluation of allograft dysfunction

- a. Technical
 - i. Inflow/outflow
 - b. Early post operative management
 - i. Endocrine
 - 1. Exogenous Insulin
 - 2. Octreotide
 - ii. GI and nutrition
 - 1. Duration of nasogastric drainage
 - 2. Initiation of enteric
 - iii. Heme
 - 1. anticoagulation
 - c. Radiology
 - i. Expected findings after pancreas transplant
 - ii. Evaluation of Vascular complications after transplant
 - iii. Evaluation enteric complications after transplant
 - d. Immunosuppression and rejection
 - i. Induction
 - ii. Maintenance immunosuppression
 - iii. Rejection
 - 1. Cell Mediated rejection and treatment
 - 2. Antibody Mediated rejection and treatment
 - 3. Pathological findings of rejection
 - iv. Graft versus host disease
 - e. Pathology
 - i. Post-transplant pancreas biopsy findings
 - f. Long term management of the post pancreas transplant patient
 - i. Trends and Disease Recurrence in Pancreas Transplant Recipients
 - ii. Malignancy Risk and Mitigation after Transplant
 - iii. Renal Disease after Pancreas Transplant
 - iv. Metabolic Complications Associated with Transplant
 - v. Routine Health Maintenance
- 8. **Complications of Pancreas Transplantation**
 - a. Early post-transplant issues
 - b. Graft Failure
 - i. Contributing factors/risk factors
 - ii. Patient Management
 - iii. Re-transplantation
 - c. Medical Complications
 - i. Renal failure
 - ii. Respiratory failure
 - iii. Cardiac complications
 - d. Technical Complications
 - i. Enteric (leak, bowel obstruction)
 - 1. Risk factors, incidence and management
 - ii. Arterial complications (thrombosis)
 - 1. Risk factors, incidence, and management
 - iii. Portal (thrombosis)

- 1. Risk factors, incidence, and management
 - e. Late complications
 - f. Re-Transplant
 - i. Early
 - ii. Late
 - g. Role of the Interventional Radiology
- 9. Allotransplantation of Pancreatic Islets**
 - a. Indications
 - b. Retrieval and isolation
 - c. Islet Transplant Procedure

ASTS Curriculum Liver Transplant Unit

1. Anatomy, Physiology and Testing of the Liver

- a. Intra-hepatic and extra- hepatic anatomy of the liver and the relationship with the adjacent & surrounding structures
 - i. Extrahepatic anatomy of the liver
 - 1. Lobes, segments, sectors
 - 2. Nomenclature systems
 - 3. Ligaments, fissures & incisures
 - 4. Anomalies
 - ii. Anatomy of the porta
 - 1. Portal vein, hepatic artery
 - 2. Bile duct, gall bladder
 - 3. Variants of normal and anomalies
 - iii. Anatomy of the retrohepatic space
 - 1. IVC and its branches
 - 2. Adrenal, kidney, diaphragm
 - iv. Intrahepatic anatomy
 - 1. Hepatic veins and variants of normal
 - 2. Embryology and the ligaments (Teres, venosum) of the liver
 - 3. Portal triad structures and segmental anatomy
 - 4. Histology of the normal liver
- b. Physiology of the liver
 - i. Bilirubin metabolism
 - ii. Coagulation
- c. Clinical hematologic & biochemical tests relevant to the liver and their indications and interpretation
 - i. Hematologic, biochemical, and histologic testing (assessment) of the liver
 - 1. Transaminases and markers of cholestasis
 - 2. Measures of liver function
 - a) static – including INR (PT), Factors V and VII, bilirubin, albumin
 - 3. Indicators of portal hypertension
 - 4. Indications for liver biopsy
- d. Liver Imaging
 - i. Techniques and Interpretation
 - 1. Ultrasound (U/S) & Doppler, Computerized Tomography (CT) Scans, Magnetic Resonance Imaging (MRI) Scans
 - 2. Nuclear tests: Proton Emission Tomographic (PET) Scans, Liver/Spleen scans, Biliary excretion (e.g. HIDA) Scans, RBC Scans
 - ii. Application of investigations to liver transplant

2. Congenital and acquired non-neoplastic Liver Disease in Adults

- a. Cirrhosis & portal hypertension
 - i. Causes of cirrhosis, diagnosis and natural history, staging and treatment options (including indications for liver transplantation) for each
 - 1. Viral Hepatitis B, C, D
 - 2. Alcoholic liver disease
 - 3. Metabolic fatty liver disease & steatohepatitis
 - 4. autoimmune liver disease

- a) autoimmune CAH
 - b) Primary biliary cholangitis
 - c) Primary sclerosing cholangitis
 - d) Hemochromatosis, Wilson's disease, alpha-1 antitrypsin deficiency
 - e) Budd Chiari syndrome
 - b. Portal hypertension
 - i. Pathophysiology
 - ii. interpretation of hematologic & biochemical testing and imaging
 - iii. non-operative treatment options & strategies
 - iv. portosystemic decompression
 - 1. indications & sequelae
 - 2. risks and benefits of TIPS and surgical shunts
 - 3. types of surgical shunts
 - a)relative indications
 - c. Physiology of End Stage Liver Disease
 - i. Neurologic
 - ii. Cardiovascular
 - iii. Renal
 - iv. Hematologic
 - v. Nutrition
 - d. Management of Complications of End Stage Liver Disease (ESLD)
- 3. Liver Transplant Evaluationⁱ**
 - a. Indications for Liver Transplant
 - i. Chronic Liver Disease/Complications of Cirrhosis
 - 1. Ascites
 - 2. Chronic gastrointestinal blood loss due to portal hypertensive gastropathy
 - 3. Encephalopathy
 - 4. Refractory variceal hemorrhage
 - 5. Synthetic dysfunction
 - 6. Recurrent infection
 - ii. Liver-based metabolic conditions with systemic manifestations
 - 1. α 1-Antitrypsin deficiency
 - 2. Familial amyloidosis
 - 3. Glycogen storage disease
 - 4. Hemochromatosis
 - 5. Primary oxaluria
 - 6. Wilson disease
 - Maple Syrup urine disease
 - iii. Systemic complications of chronic liver disease
 - 1. Hepatopulmonary syndrome
 - 2. Portopulmonary hypertension
 - iv. Acute Liver Failure
 - 1. Causes of acute liver failure
 - 2. Investigation and prognosis
 - a)classification systems including King's College criteria

3. Treatment strategies
 - a) role of liver transplantation
 - b) management of ALF
- v. Liver tumors
 1. Benign lesions
 - a) Indications
 - i. Diagnostic uncertainty
 - ii. Possible malignant transformation
 - iii. Premalignant lesions
 - iv. Metabolic liver disease
 - v. Complications like rupture or hemorrhage
 - vi. Significant patient symptoms due to the tumors
 2. Etiology
 - a) Hepatic Epithelioid Hemangioendothelioma
 - b) Hepatic Adenoma/Adenomatosis
 - c) Hepatic Hemangioma
- b. Components of the Liver Transplant Evaluation
 - i. Consultations
 1. Hepatology Evaluation
 2. Surgical Evaluation
 3. Cardiac Evaluation
 4. Anesthesia Evaluation
 5. Dental Assessment
 6. Psychiatry, Psychology, Mental Health and/or Alcohol and Other Drug Abuse (AODA)
 7. Nutrition Evaluation
 8. Social Work Evaluation
 - ii. Testing
 1. Laboratory testing (medical and regulatory)
 2. Cross sectional imaging
 3. Cardio-pulmonary assessment
 4. General health screening (Colonoscopy, Pap smear, Mammogram)
 5. Frailty screening
 6. Bone disease screening (when indicated)
 - iii. Financial and insurance screening and counselling
 - iv. Combined organ transplant
 1. SLK
 - a) SLK Criteria
 - b) Kidney safety net
 2. Heart liver
- c. Contraindications to Liver Transplantation
 - i. Severe cardiac or pulmonary disease
 - ii. Unrecoverable neurologic disease, impending cerebral herniation
 - iii. Malignancy with untreatable/unresectable metastasis
 - iv. Uncontrolled sepsis
 - v. Anatomic abnormality that precludes transplantation
 - vi. Hemodynamic instability

- vii. Lack of potential social support system or ability to adhere to post transplant requirements
- d. Listing for Transplantation
 - i. Categories of listing for Liver specifically
 - ii. Model for End Stage Liver Disease (MELD), MELD exception, Status 1A
 - iii. Removal from the Waiting list registry

4. Liver Donor Selection

- a. Donor Recipient Matching
 - i. Donor and Graft Evaluation
 - 1. Donor History and conditions
 - a) Malignancy
 - b) Liver disease or viral hepatitis
 - a) Fibrosis
 - b) Steatosis
 - c) Infectious Disease
 - d) Shock/hemodynamic Instability
 - e) Trauma
 - 2. Pre Operative Imaging
 - 3. Organ Inspection
 - 4. Size
 - 5. Donor Liver Biopsy and Pathology findings
 - ii. Special Considerations
 - 1. Split Liver Transplantation
 - 2. Domino Transplantation
 - 3. Machine Perfusion
 - iii. Managing consent and disclosure of donor considerations and risk
- b. Deceased Donor
 - i. Donation after Cardiac Death - implications in liver transplantation
 - 1. Normothermic Regional Perfusion
 - ii. Donation after Brain Death
- c. Living Donor
 - i. Appreciate the overall benefit of live donor liver transplantation (LDLT) as compared to deceased donor transplantation and waiting list risk
 - ii. Profile of complications in LDLT setting versus deceased donor liver transplants
 - iii. Unique complications and concerns with living donor liver transplantation: Small for size, bile duct leak/strictures
 - iv. Donor Evaluation
 - 1. Medical and Surgical considerations
 - 2. Psychosocial considerations
 - 3. Consent
 - 4. Exclusion Criteria
 - 5. Anatomic evaluation (Vascular, biliary)
 - 6. Donor-recipient matching
 - a) Liver volume
 - b) Small for size (factors and mitigation strategies)
 - 7. Living donor Liver Outcomes
 - a) Morbidity, mortality, Quality of Life

5. Principles of Liver Preservation

- a. Mechanisms of Injury
 - i. Pre-preservation
 - ii. Cold Preservation
 - iii. Rewarming Injury
 - iv. Reperfusion Injury
- b. Components of Perfusion
 - i. Exsanguination
 - ii. Hypothermia
 - iii. Preservation Solutions
- c. Novel Perfusion Strategies
 - i. Normothermic regional perfusion
 - ii. Normothermic machine perfusion
 - iii. Hypothermic oxygenated machine perfusion

6. Liver Transplant Operation

- a. Transplant Hepatectomy
 - i. Liver transplant techniques
 - 1. Whole graft
 - a) Approach to outflow
 - b) Portal vein considerations
 - Options for inflow
 - Portal Vein Thrombosis
 - c) Arterial approaches and reconstructions
 - d) Biliary reconstruction
 - e) Special Considerations: History of Transjugular Intrahepatic Portosystemic shunt (TIPS), history of Spontaneous Bacterial Peritonitis (SBP), Retransplant, Budd Chiari, Polycystic Liver disease, previous abdominal or hepatobiliary surgery, hepatic hydrothorax, history of liver directed therapy or hepatic arterial infusion pump
 - 2. Partial graft techniques
 - 3. Veno-venous bypass
 - ii. Liver Transplant Anesthesia considerations
 - 1. Pathophysiology of liver disease
 - a) General considerations (Systemic Vascular Resistance, Cardiac Output)
 - b) Systemic conditions: severe hyponatremia, hepatopulmonary, portopulmonary hypertension, hepatorenal syndrome, cerebral edema
 - 2. Intraoperative hemodynamic monitoring and support
 - a) Central Access
 - b) Rapid infusion options
 - c) Veno venous bypass
 - d) Transesophageal Echo (TEE)
 - e) Swan Ganz Catheter
 - 3. Thermal hemostasis

4. Managing coagulopathy
 - a) Advanced monitoring: Thromboelastogram (TEG), Rotational Thromboelastometry (ROTEM)
 - b) Pharmacologic adjuncts: tranexamic acid, activated factor 7
 - c) Topical hemostatic agents
5. Reperfusion concerns
 - a) Electrolytes, volume, temperature
6. Intraoperative renal replacement therapy
- iii. Intraoperative complications
 1. Extreme blood loss
 2. Intraoperative circulatory arrest
 3. Intracardiac thrombus
 4. Air embolus
 5. Graft non-function
 6. Arterial dissection

7. Management of Post Liver Transplant Patients

- a. Intensive Care Management
 - i. Evaluation of the early allograft function
 1. Early allograft dysfunction evaluation and management (donor and recipient factors and management)
 - a) Donor factors (steatosis)
 - b) Operative factors (Massive transfusion, vasopressors)
 - c) Recipient factors (right heart failure, acute kidney injury, acute tubular necrosis)
 - d) Anatomic and physiologic factors
 - Inflow (portal and arterial)
 - Outflow
 - Flow modulation
 2. Primary non-function
 - ii. Patient care management
 1. Neuro (hyponatremia, seizure, delirium, cerebral edema)
 2. Cardiac (cardiomyopathy, heart failure, ischemic heart disease)
 3. Respiratory (pulmonary edema, pneumothorax, hemo/hydrothorax, Acute Respiratory Distress Syndrome, Transfusion Related Acute Lung Injury, aspiration, pneumonia)
 4. Renal and fluids (CVVH, Hemodialysis)
 5. GI and nutrition (variceal/gastropathy bleed, ulcer)
 6. Heme (management of coagulopathy and hemorrhage)
 7. Infectious Disease (prophylaxis, donor derived infection)
 8. Immunologic (induction, maintenance)
- b. Short term management of the post liver transplant patient
 - i. Monitoring Graft Function
 - ii. Management co-morbidities
 - iii. Managing medication side effects (Ulcer prophylaxis, DM, HTN)
 - iv. Induction and maintenance immunosuppression
 - v. Monitoring for infection
 - vi. Rehabilitation

- vii. Psychosocial support and management
 - c. Pharmacology
 - d. Radiology
 - i. Expected findings after liver transplant
 - ii. Evaluation of Vascular complications after transplant
 - iii. Evaluation of Biliary complications after transplant
 - e. Immunosuppression and rejection
 - i. Maintenance immunosuppression
 - 1. Side effects
 - ii. Rejection
 - 1. Cell Mediated rejection and treatment
 - 2. Antibody Mediated rejection and treatment
 - 3. Pathological findings of rejection
 - iii. Graft versus host disease
 - f. Pathology
 - i. Post transplant liver biopsy findings
 - g. Long term management of the post liver transplant patient
 - i. Trends and Disease Recurrence in Liver Transplant Recipients
 - ii. Malignancy Risk and Mitigation after Transplant
 - iii. Renal Disease after Liver Transplant
 - iv. Metabolic Complications Associated with Transplant
 - v. Routine Health Maintenance
- 8. Complications of Liver Transplantation**
 - a. Early posttransplant issues
 - i. Graft Failure
 - 1. Contributing factors/risk factors
 - 2. Patient Mgmt
 - 3. Re-transplantation
 - ii. Medical Complications
 - 1. Renal failure
 - 2. Respiratory failure
 - 3. Cardiac complications
 - iii. Technical Complications
 - 1. Biliary (leak, stenosis, necrosis)
 - a) Risk factors, incidence and management
 - 2. Arterial complications (HAT, stenosis, Pseudoaneurysm)
 - a) Risk factors, incidence, and management
 - i. Portal hyperperfusion
 - ii. Median Arcuate ligament
 - 3. Portal (stenosis, thrombosis)
 - a) Risk factors, incidence, and management
 - 4. Outflow
 - 5. Ischemic cholangiopathy
 - b. Late complications
 - c. Re-Transplant
 - i. Early
 - ii. Late

- d. Role of the Interventional Radiology
- e. Role of the Endoscopy
- 9. Transplant Oncology**
 - a. Indications
 - i. Liver transplant for primary liver cancers
 - 1. Hepatocellular carcinoma
 - a) Surveillance in patients with cirrhosis
 - b) Diagnosis
 - c) Staging
 - d) Management
 - e) Role of transplantation
 - i. Risk stratification
 - ii. Contraindication
 - f) Criteria for exception
 - 2. Cholangiocarcinoma
 - a) Intrahepatic (experimental)
 - b) Hilar
 - c) Incidental
 - 3. Neuroendocrine tumors
 - ii. Liver transplant for metastatic liver disease
 - 1. Indications
 - 2. Peri-transplant protocols
 - b. Multidisciplinary care
 - i. Treatment modalities
 - 1. Surgical treatment
 - 2. Transplantation
 - 3. Systemic therapy
 - a) Chemotherapy
 - b) Immunotherapy and rejection
 - 4. Radiotherapy, brachytherapy, radio-sensitizing chemotherapy
 - 5. Liver directed treatment
 - c. Allocation
 - i. Exception for malignancy
 - ii. Living donor
 - d. Operative considerations
 - i. Diagnostic laparoscopy
 - ii. Lymph node dissection/sampling
 - iii. Prior surgery or procedures (liver resection, ablation)
 - iv. Radiation fibrosis
 - v. Hepatic artery damage requiring alternative arterial inflow
 - e. Post transplant surveillance
- 10. Multivisceral and Intestinal Transplant**
 - a. Isolated intestine, liver-intestine, multivisceral transplant
 - i. indications

ⁱ Evaluation for liver transplantation in adults: 2013 practice guideline by the

ASTS Curriculum: Pediatric Transplant

1. Anatomy, Physiology and Testing of the Liver

- a. Intrahepatic and extra- hepatic anatomy of the liver and the relationship with the adjacent & surrounding structures
- b. Anatomic variants associated with congenital liver disease
 - i. Atretic portal vein
 - ii. Interrupted vena cava
 - iii. Situs inversus
 - iv. Intestinal malrotation
 - v. Polysplenia
 - vi. Vascular anomalies (including cerebral aneurysms)

2. Liver Diseases in Children

- a. Primary Liver Diseases
 - i. Biliary Atresia (Kasai portoenterostomy)
 - ii. Progressive familial intrahepatic cholestasis (PFIC)
 - iii. Autoimmune hepatitis
 - iv. Alagille syndrome
 - v. Ductal plate malformations (Autosomal recessive polycystic kidney disease, Caroli's (congenital saccular dilation of the intrahepatic bile duct) disease, Congenital hepatic fibrosis)
 - vi. Polycystic Liver/Kidney Disease
 - vii. Alpha 1 antitrypsin
 - viii. Wilson's (hepatolenticular degeneration) disease
 - ix. Neonatal hemochromatosis
 - x. Neonatal hepatitis
 - xi. Viral hepatitis
 - xii. Budd Chiari
 - xiii. Primary Sclerosing Cholangitis
- b. Secondary Liver Diseases
 - i. Cystic fibrosis
- c. Liver tumors and Malignancy
 - i. Hepatoblastoma
 - ii. Hepatocellular neoplasm NOS
 - iii. Hepatocellular carcinoma
 - iv. Infantile hemangioma
- d. Inborn Errors of Metabolism
 - i. Organic Acidemias (Propionic Acidemia, Methylmalonic (MMA), Maple Syrup Urine Disease (Branched-chain ketoaciduria)
 - ii. Urea cycle defects
 - iii. Primary hyperoxaluria
 - iv. Glycogen storage disease
 - v. Crigler-Najjar syndrome type I (CNI) uridine diphosphate glucuronosyltransferase (UGT) deficiency

- vi. Bile acid synthesis disorders
- vii. Hereditary tyrosinemia type 1 (refractory to NTBC)
- viii. Fatty Acid Oxidation Defects
- ix. Familial hypercholesterolemia
- x. Mitochondrial hepatopathy or systemic mitochondrial disease

e. Acute Liver Failure

3. Indications for Liver Transplant in children:

- a. Recurrent Cholangitis
- b. Portal hypertension (with or without variceal hemorrhage)
- c. Delayed growth and development
- d. Pruritis
- e. Synthetic dysfunction
- f. Refractory Ascites
- g. Hepatic or toxic encephalopathy
- h. Fulminant Wilson's (hepatolenticular degeneration) disease
- i. Acute Liver Failure
 - i. Causes of acute liver failure
 - ii. Investigation and prognosis
 - iii. classification systems including King's College criteria
 - iv. Treatment strategies
 - v. role of liver transplantation

4. Systemic complications of chronic liver disease or systemic associations with congenital diseases:

- a. Hepatopulmonary syndrome
- b. Portopulmonary hypertension
- c. Structural cardiac disease
- d. Renal insufficiency/dysfunction
- e. Doxorubicin associated cardiomyopathy (hepatoblastoma)

5. Components of the Liver Transplant Evaluation

- a. Consultations
 - i. Hepatology Evaluation
 - ii. Surgical Evaluation
 - iii. Cardiopulmonary Evaluation
 - iv. Anesthesia Evaluation
 - v. Dental Assessment
 - vi. Psychiatry, Psychology, Neurocognitive/neurodevelopmental assessment
 - vii. Nutrition Evaluation
 - viii. Social Work Evaluation (patient and family; identify family/pediatric resources, medical foster care)
- b. Testing
 - i. Laboratory testing (medical and regulatory)
 - ii. Cross sectional imaging
 - iii. Nutrition and developmental screening
 - iv. Vaccinations
 - 1. Age appropriate vaccinations

- 2. Timing vaccinations with transplant
- c. Combined organ transplant
 - i. Simultaneous Liver Kidney
 - ii. Heart liver

6. Contraindications to Liver Transplantation

- a. Severe cardiac or pulmonary disease
- b. Unrecoverable neurologic disease (??Severe cerebral edema)
- c. Generalized extrahepatic malignancy (exceptions hepatoblastoma with isolated lung mets)
- d. Malignancy with untreatable/unresectable metastasis (??neuroendocrine??)
- e. Uncontrolled sepsis
- f. Anatomic abnormality that precludes transplantation
- g. Hemodynamic instability
- h. Lack of potential social support system or ability to adhere to post transplant requirements
- i. Alper's syndrome or valproate-associated liver failure
- j. Severe, life-threatening extrahepatic multiorgan mitochondrial disease
- k. Hemophagocytic lymphohistiocytosis

7. Listing for Transplantation

- a. Categories of listing for Liver
 - i. PELD, MELD, Exception, Status 1A, 1B
- b. Allocation to patients listed less than 18 years old at time listing

8. Donor Recipient Matching

- a. Donor and Graft Evaluation
 - i. Deceased donor:
 - 1. Special considerations in pediatric liver graft evaluation
 - 2. Size (donor and recipient)
 - 3. Graft type (whole organ versus technical variant)
 - 4. Additional donor vessel use
 - ii. Living donor:
 - 1. Donor technical considerations (size/contour of graft, vasculature)
 - 2. Donor genetic screening for familial liver diseases
 - 3. Additional donor vessel use (deceased v from living donor)

9. Transplant Hepatectomy

- a. Liver transplant techniques
 - i. Approach to outflow
 - 1. Triangulation
 - 2. Graft rotation
 - ii. Portal vein consideration
 - 1. Options for inflow
 - 2. Portal Vein Thrombosis
 - 3. Portal vein atresia
 - 4. Use of interposition or jump grafts
 - iii. Arterial approaches and reconstructions
 - iv. Biliary reconstruction
 - v. Special Anatomic Considerations:

1. Interrupted vena cava
2. Intestinal Malrotation
3. Situs inversus
4. Preduodenal portal vein

10. Liver Transplant Anesthesia considerations

- a. Special considerations in pediatric patients:
 - i. Venous and arterial access
 - ii. Blood volume and resuscitation
 - iii. Pain control

11. Immunosuppression

- a. Induction and Maintenance immunosuppression
- b. Tolerance
- c. ABO incompatible

12. Long term management of the post liver transplant patient

- a. Bone and Endocrine management
- b. Psychosocial development
- c. Neurocognitive development
- d. Skin cancers
- e. Technical transplant related complications (HAT, PV stenosis, biliary issues)
- f. transplant

13. Transitioning from pediatric to adult care

- a. Principles of transitioning care and personal health management
- b. Care of the adolescent transplant patient
- c. Timing of transitioning education
- d. Timing of transitioning

PEDIATRIC KIDNEY TRANSPLANTATION

1. Kidney Diseases in Children

- a. Intrinsic Kidney Diseases
- b. Urologic Diseases

2. Indications for Kidney Transplant in children:

3. Systemic complications of chronic KIDNEY disease or systemic associations with congenital diseases:

- a. Secondary to kidney disease:
 - i. Feeding intolerance
 - ii. Growth retardation
 - iii. Acidosis
 - iv. Hyperparathyroidism
 - v. Growth hormone resistance
 - vi. Cardiovascular disease
 - vii. Neurocognitive deficits
 - viii. High output kidney failure
- b. Prematurity associated conditions

- i. Pulmonary hypoplasia
- b. Genetic syndromes
- 4. **Components of the Kidney Transplant Evaluation**
 - a. Consultations
 - i. Nephrology Evaluation
 - ii. Urologic Evaluation
 - iii. Surgical Evaluation
 - iv. Cardiopulmonary Evaluation
 - v. Anesthesia Evaluation
 - vi. Dental Assessment
 - vii. Psychiatry, Psychology, Neurocognitive/neurodevelopmental assessment
 - viii. Nutrition Evaluation
 - ix. Social Work Evaluation (patient and family; identify family/pediatric resources, medical foster care)
 - b. Testing
 - i. Laboratory testing (medical and regulatory)
 - ii. Cross sectional imaging
 - iii. Nutrition and developmental screening
 - iv. Vaccinations
 - 1. Age appropriate vaccinations
 - 2. Timing vaccinations with transplant
 - v. Dynamic Urologic testing
 - 1. VCUG
 - 2. Urodynamics
 - c. Combined organ transplant
 - i. Simultaneous Liver Kidney

5. Contraindications to kidney Transplantation

6. Listing for Transplantation

- a. Allocation of kidneys to patients listed at age less than 18 years old

7. Donor Recipient Matching

- a. Donor and Graft Evaluation
 - i. Deceased donor:
 - 1. Size (donor and recipient)
 - ii. Living donor

8. Pediatric kidney transplant techniques

- a. Implantation
 - i. Location
 - 1. Intraperitoneal
 - 2. Retroperitoneal
 - ii. Vasculature
 - 1. Prevention of graft thrombosis
- b. Native nephrectomy
 - i. Polyuria
 - ii. Refractory hypertension

- iii. Infectious risk
 - iv. Space
- c. Genitourinary considerations
 - i. Mitrofanoff
 - ii. Bladder augmentation
 - iii. Ureteral implantation
 - iv. Chronic catheterization
- d. Staged versus simultaneous procedures

9. Kidney Transplant Anesthesia considerations

- a. Special considerations in pediatric patients:
 - i. Venous and arterial access
 - ii. Blood volume and resuscitation
 - iii. Blood pressure augmentation
 - iv. Pain control

10. Immunosuppression

- a. Induction and Maintenance immunosuppression
- b. ABO incompatible
- c. Rejection
 - i. Incidence
 - ii. Treatment

11. Long term management of the post liver transplant patient

- a. Bone and Endocrine management
- b. Psychosocial development
- c. Neurocognitive development
- d. Mental health
- e. Skin cancers
- f. Technical transplant related complications

12. Transitioning from pediatric to adult care

- a. Principles of transitioning care and personal health management
- b. Care of the adolescent transplant patient
- c. Timing of transitioning education
- d. Timing of transitioning

ASTS Curriculum: Hepatobiliary Curriculum

Liver

1. Anatomy, Physiology and Testing of the Liver

- a. Intra-hepatic and extra- hepatic anatomy of the liver and the relationship with the adjacent & surrounding structures
 - i. Extrahepatic anatomy of the liver
 - 1. Lobes, segments, sectors
 - 2. Nomenclature systems
 - 3. Ligaments, fissures & incisures
 - 4. Anomalies
 - ii. Anatomy of the porta
 - 1. Portal vein, hepatic artery
 - 2. Bile duct, gall bladder
 - 3. Variants of normal and anomalies
 - iii. Anatomy of the retrohepatic space
 - 1. IVC and its branches
 - 2. Adrenal, kidney, diaphragm
 - iv. Intrahepatic anatomy
 - 1. Hepatic veins and variants of normal
 - 2. Embryology and the ligaments (Teres, venosum) of the liver
 - 3. Portal triad structures and segmental anatomy
 - 4. Histology of the normal liver
- b. Physiology of the liver
 - i. Bilirubin metabolism
 - ii. Coagulation
- c. Clinical hematologic & biochemical tests relevant to the liver and their indications and interpretation
 - i. Hematologic, biochemical, and histologic testing (assessment) of the liver
 - 1. Transaminases and markers of cholestasis
 - 2. Measures of liver function
 - a. static – including INR (PT), Factors V and VII, bilirubin, albumin
 - b. dynamic – including clearance tests, e.g. ICG, galactose, aminopyrine, lidocaine (MEGX)
 - 3. Indicators of portal hypertension
 - 4. Indications for liver biopsy
- d. Liver Imaging
 - i. Techniques and Interpretation
 - 1. Ultrasound (U/S) & Doppler, Computerized Tomography (CT) Scans, Magnetic Resonance Imaging (MRI) Scans (including intraoperative US)
 - 2. Nuclear tests: Proton Emission Tomographic (PET) Scans, Liver/Spleen scans, Biliary excretion (e.g. HIDA) Scans, RBC Scans
 - ii. Application of investigations to liver transplant

2. Benign Lesions of the Liver

- a. Presentation, evaluation, natural history

b. Treatment Options and indications for intervention

- i. Liver cyst
 - 1. Simple cyst
 - 2. Polycystic Liver Disease
 - 3. Biliary Cystadenoma
- ii. Liver Abscess
 - 1. Pyogenic and fungal liver abscess
 - 2. Echinococcal liver cyst
- iii. Hepatic Adenoma
- iv. Focal Nodular Hyperplasia
- v. Hemangioma
- vi. Nodular regenerative hyperplasia

2. Malignant Lesions of the liver

- a. Presentation, evaluation, natural history
- b. Treatment Options and indications for intervention particular indications/contraindications for liver transplantation
 - i. Hepatocellular Carcinoma
 - ii. Cholangiocarcinoma (intrahepatic)
 - iii. Epithelioid hemangioendothelioma, lymphoma, sarcoma
 - iv. Metastatic Disease
 - 1. Neuroendocrine
 - 2. Colorectal

The Biliary Tract Including Gallbladder

1. Anatomy, Physiology

- a. anatomy of the hepatic duct, hilar plate, gallbladder and cystic duct.
 - i. Anatomic variants
 - ii. blood supply
- b. bile metabolism
- c. imaging
 - i. Axial & body imaging techniques:
 - ii. U/S, CT scan and MRI scan, including MRCP
 - iii. Endoscopic U/S
 - iv. Direct contrast imaging
 - v. Percutaneous transhepatic cholangiogram (PTC) and cholecystography and Endoscopic retrograde cholangio-pancreatography (ERCP)
 - vi. Endoscopic assessment of Ampulla of Vater
 - vii. Nuclear biliary excretion imaging (HIDA scan)

2. Congenital and Non-neoplastic biliary disease

- a. For the following presentation, classification (if applicable), evaluation, natural history, and treatment options
 - i. Choledochal cyst (inclusive of Caroli's Disease)
 - ii. Congenital hepatic fibrosis
 - iii. Biliary Atresia

- iv. Alagille's Syndrome
- v. Cholelithiasis/Cholecystitis/Choledocholithiasis/Cholangitis
- vi. Adenomyomatosis
- vii. Strictures
- viii. Recurrent pyogenic cholangitis
- ix. B-IPMN

3. Neoplastic Biliary Disease

- a. For the following presentation, classification (if applicable), evaluation, natural history, and treatment options
 - i. Gallbladder Carcinoma
 - ii. Hilar Cholangiocarcinoma
 - iii. Extrahepatic/distal cholangiocarcinoma

Pancreas/Duodenum

1. Anatomy, physiology, pancreas and duodenum

- a. Arterial supply and venous drainage
- b. Lymphatics and regional lymph nodes
- c. Anatomy of the pancreatic duct and variants (think embryology fits here)
- d. Markers of pancreatic injury
- e. Measures of pancreatic exocrine function

2. Pancreas Pathology

- a. Solid Malignancies of pancreas : Presentation, classification (if applicable), evaluation, natural history, and treatment options
 - i. PDAC
 - ii. Neuroendocrine tumors
 - iii. Functional/Non-functional
- b. Cystic lesions of pancreas: Presentation, classification (if applicable), evaluation, natural history, and treatment options, indications for resection, ability to describe workup and clinical differentiation
 - i. Microcystic serous cystadenoma
 - ii. Mucinous cystic neoplasm
 - iii. Intraductal papillary mucinous neoplasm
 - iv. Pseudocyst
- c. Pancreatitis
 - i. Staging/prognosis
 - ii. Mgt of acute pancreatitis including surgical options/complication
 - iii. Mgt of chronic, drainage procedures, surgical options/indications including auto-islet transplantation

3. Duodenal Pathology

- a. Benign/congenital diseases
 - i. Duodenal atresia
 - ii. Duodenal diverticulum
 - iii. Complicated duodenal ulcer disease
 - iv. Adenoma
- b. Malignant diseases

- i. Adenocarcinoma
- ii. GIST
- iii. Neuroendocrine tumor