Renal Disease and Infection

(Hemo Dialysis, Peritoneal Dialysis and Transplantation)

Bridget Kelly RN-BC, MSN

Jefferson. University Hospital

Objectives

- Describe the risk factors and incidence of infection in hemodialysis, peritoneal dialysis and transplant patients.
- Identify 2 risk reduction strategies that can be implemented to reduce the incidence of infection in hemodialysis, peritoneal dialysis and transplant patients.
- List (3) common causes of post transplant infection, and subsequent treatment options.
- Identify (2) patient education strategies that can be taught to decrease infection in the renal population.

Jefferson. University Hospital

Background

- In the U.S., kidney disease is the *ninth* leading cause of death.
- Diabetes and Hypertension are the most common causes of chronic kidney failure.
- People with kidney disease often face unique challenges when it comes to infection.

Jefferson. University Hospital

National Organ Waiting List Candidates: as of 9/1/12

Kidney	93,132
Pancreas	1,245
Kidney/Pancreas	2,149
Liver	15,995
Intestine	256
Heart	3,262
Lung	1,619
Heart/Lung	52

Jefferson. University Hospital

Organ Procurement and Transplantation Network, 2012

One Year Adjusted Graft Survival by Organ and Year of Transplant

Survival (%)	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Kidney: Deceased Donor	87.5%	87.4%	88.6%	88.8%	89.0%	89.8%	90.1%	90.5%	91.5%	92.1%
Kidney: Living Donor	94.4%	94.1%	94.4%	95.0%	95.4%	95.2%	95.2%	96.1%	96.6%	96.4%
Pancreas Transplant Alone	83.1%	74.1%	76.3%	79.8%	67.0%	75.5%	85.9%	74.6%	75.1%	74.3%
Pancreas After Kidney	79.7%	73.5%	82.0%	77.2%	77.3%	78.3%	76.7%	78.2%	81.6%	78.9%
Kidney-Pancreas: Kidney	91.6%	92.4%	91.4%	91.6%	92.3%	92.2%	93.3%	91.8%	93.3%	92.6%
Kidney-Pancreas: Pancreas	82.3%	82.9%	84.5%	84.7%	85.2%	84.5%	86.4%	83.4%	86.1%	86.1%
Liver: Deceased Donor	79.1%	80.3%	80.1%	82.0%	81.6%	82.8%	81.4%	83.1%	85.5%	85.0%
Liver: Living Donor	72.8%	77.3%	80.7%	80.2%	84.4%	84.5%	84.4%	86.1%	86.9%	90.2%
Intestine	50.3%	69.8%	61.9%	70.8%	77.9%	77.8%	73.5%	70.5%	75.4%	74.6%
Heart	83.3%	85.5%	85.5%	86.5%	87.6%	87.8%	87.2%	87.6%	88.4%	88.4%
Lung	73.7%	74.8%	75.2%	79.2%	81.7%	83.0%	81.0%	82.9%	80.5%	83.0%
Heart-Lung	56.6%	63.5%	74.4%	62.0%	51.2%	73.7%	76.7%	71.1%	90.5%	65.2%

Jefferson. University Hospital

Scientific Registry of Transplant Patients, (2012)

Absolute Contraindications for Transplant

- Active Infection
- Irreversible severe CAD
- Active malignancy
- History of non compliance with no behavioral change
- Limited ability to function without adequate support system
- No insurance
- Active uncontrolled psychiatric disease
- Uncontrolled HIV or AIDS
  - Special Listing considerations HIV (cd4 count, special HIV policy)
- Substance abuse within past 6 months
- Other medical conditions that could impede graft function

(No absolute age cutoff)
80 kidneys transplanted at Jefferson in 2011

Jefferson. University Hospital

Transplant Background

There have been significant improvements in survival rates due to:

- Improved surgical technique
- Appropriate evaluation for infection risk
- Better donor screening
- Better tissue typing
- Testing for presensitization
- Therapeutic prescription

Jefferson. University Hospital

Transplant

- Infection is one of the *two* major complications that are relatively common after surgery.
- Infection is the leading cause of death in solid organ transplant recipients.
- Transplant recipients are *most at risk* for infection in the early postoperative period when immunosuppression doses are highest.

Jefferson. University Hospital

Causes of Infection Complications:

- Immunosuppression
- Pre-existing infections
- Frequent blood products transfusions
- Major surgical interventions

Jefferson. University Hospital

How are Infection and Rejection related?

↑ Immunosuppression → ↓ Risk of Rejection
↑ Risk of Infection

↓ Immunosuppression → ↑ Risk of Rejection
↓ Risk of Infection

Jefferson. University Hospital

Infection in Solid-Organ Transplant Recipients

- The risk of infection in transplant patients is largely determined by the interaction of 3 factors:

1. Epidemiological exposure
2. Current preventive antimicrobial therapy
3. The patients net state of immunosuppression

Jefferson. University Hospital

Risk Factors for Infection Post Transplant

- Pre-transplant host factors
- Preoperative factors
- Type of organ transplanted
- Perioperative factors
- Donor factors
- Immunosuppressive regimen
- Rejection history
- Current antimicrobial regimen
- Post-transplant exposure
- Onset of symptoms

Jefferson. University Hospital

Infection Risk in Transplant Recipients

- Calcinuerin Inhibitors
  - (Cyclosporine and Tacrolimus)
- PCP and CMV
- Antimicrobial resistance

(NEJM, 2007)

Jefferson. University Hospital

Polyomavirus Type BK Neuropathy

- The virus disseminates to the kidneys and urinary tract where it persists for the life of the individual.
- 80% general population.
- Up to 10% of renal transplant patients progress to BK virus nephropathy (BKVN) and up to 80% of these patients lose their grafts.
  - The onset of nephritis can occur as early as several days post-transplant to as late as 5 years.
- BKVN is associated with ureteral stenosis, interstitial nephritis and graft failure.

Jefferson. University Hospital

Transplantation and Infection

- It is more difficult to recognize infection in transplant recipients than it is in persons with normal functioning immune systems.
- The spectrum of potential pathogens is **broad**, and infection often progresses **rapidly**.
- Early and specific microbiologic diagnosis is essential for guiding treatment and minimizing nonessential drug therapy.
- Invasive diagnostic procedures are often required for accurate and timely diagnosis

(NEJM, 2007)

Jefferson. University Hospital

Risk of Infection Post Transplant

- Changes over time, particularly with modification in immunosuppression.
- No assays accurately measure a patients risk of infection
- The risk of infection in the transplant recipient is a continuous function of the interplay between these factors.
  - Rejection
  - Infection
  - Toxixity

Jefferson. University Hospital

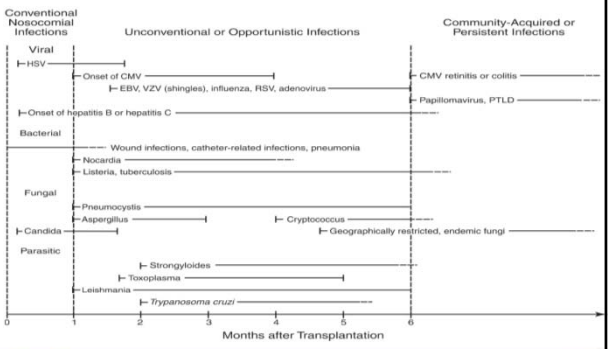
Common Infections after Transplantation

- First month:
  - Reactivation of herpes simplex virus
  - Fungal (candida)
- Month 2-6:
  - CMV, Epstein Barr Virus, Listeria and latent herpes
  - Fungal (PCP, aspergillus, cryptocoocus)
- After 6 months:
  - Upper respiratory infection, influenza and adenoviruses
  - PTLD, CMV, geographic endemic fungi

Jefferson. University Hospital

Usual Sequence of Infections after Organ Transplantation

Michelle A. Josephson



Jefferson. University Hospital

Transplant Organ Specific Infection Sources

Kidney

- Urinary Tract Infection
- Blood stream infection
- Infections in native kidneys
- Occult abscesses
- Infections related to dialysis access devices
- Wound Infection
- Pneumonia

Jefferson. University Hospital

Types of Infections: Bacterial Infections

- Most common in the immediate post-operative period with Enterococci or staphylococci representing the most common organisms isolated.
  - Other sources of infection:
    - Respiratory tract
    - Urinary tract and indwelling catheters

Jefferson. University Hospital

Bacterial Infections

- Due to immunosupression and long standing malnutrition before transplant: these patients may not manifest the normal signs of sepsis.
  - Require:
    - Frequent cultures of blood
    - Frequent cultures of sputum
    - Frequent cultures of urine

Jefferson. University Hospital

Herpes virus Infections in Organ Transplant

- Herpes virus infections remain a major cause of morbidity and mortality for a majority of transplant recipients.
- Latent
- Infections caused by the eight human herpes viruses continue to challenge the clinical management of transplant recipients

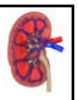
Jefferson. University Hospital

CMV (Human Herpes virus 5)

- Approximately 40 to 60% of the population has been infected with this virus
- CMV Transmission
- In an immunocompetent individual, primary CMV infections are generally asymptomatic, even among infants.
- In immunosuppressed patients: CMV is a major cause of disease and mortality, with a symptomatic infection occurring in 20 to 60% of all transplant recipients.

Jefferson. University Hospital

CMV



- Cause of CMV infection post transplantation
- In these immunosuppressed individuals, acute CMV infections can lead to a CMV syndrome characterized by:
  - Fever
  - Leukopenia
  - Malaise
  - Arthralgia
  - Macular rash
  - Invasive disease such as hepatitis or pneumonitis

Jefferson. University Hospital

Treatment of CMV

- The first treatment approved for the treatment of CMV was Ganciclovir (Cytovene).
  - First line therapy is IV ganciclovir
- Valganciclovir (Valcyte) and Acyclovir (Zovirax) are newer drugs for the treatment of CMV disease in transplant recipients.
  - oral prodrugs that rapidly convert to ganciclovir, play a major role in the treatment and prevention of CMV infections
  - Both drugs can be administered orally and have increased oral bioavailability.
  - Valganciclovir is in the antiviral class of medications.
- They work by preventing the spread of CMV disease or slowing the growth of CMV.

Jefferson. University Hospital

Nursing Perspective on Infection

- The key to effective treatment of infection is invoking strategies for the prevention and early identification of new infections.
- An important part of nursing care is identifying the pre-transplant serological status of the patient and the serologies of the donor to identify those patients at higher risk for opportunistic infections and educate patients regarding their particular risk factors.
  - This includes the types of infections they are at risk for during each post-transplant phase.
- It is important to stress the need for compliance with prophylaxis.
  - Understanding the rationale for the drug regimen may increase adherence.
- Patients need to be educated regarding how to identify signs and symptoms of infection and when to call the transplant team.

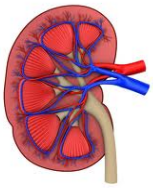
Jefferson. University Hospital

Critical Elements of Education on Infection

- Wash hands often.
- Notify the transplant team of temperature, signs and symptoms of i
- Notify the transplant team before starting antibiotics prescribed by clinicians, who are not part of the transplant team.
- Complete all courses of antibiotics.
- Avoid people with colds and infections.
- Avoid handling animal waste and contact with animals that roam outside.
- Do not change the bird cage or the cat litter.
- Avoid construction sites.
- Wear gloves when gardening.
- Keep vaccinations up to date.
- Avoid live vaccines, and if family members receive live vaccines, notify the transplant team.
- Consider food safety.
- Avoid raw meats and fish.
- Eggs should be eaten cooked.
- Wash fruits and vegetables well.
- Drink bottled water when traveling outside the United States.
- Thoroughly clean countertops.

Jefferson. University Hospital

Peritoneal Dialysis



Jefferson. University Hospital

Infection and Peritoneal Dialysis

1. History of PD
2. Prevention of PD-related infections
3. Exit-site and tunnel infections
4. Initial presentation and management of peritonitis
5. Subsequent management of peritonitis (organism specific)
6. Future research

Jefferson. University Hospital

Peritoneal Dialysis

- Relatively simple and effective technique for the treatment of End Stage Renal Disease (ESRD)
- Introduced in the late 1970's
- PD Process
- The peritoneal membrane acts as a partially permeable membrane.

Jefferson. University Hospital

PD Exchanges

- The dialysate is left for a period of time to absorb waste products, and is drained out through the tube and then discarded.
- Ultrafiltration occurs via osmosis.
- Peritoneal dialysis is less efficient than hemodialysis, but because it is carried out for a longer period of time the net effect in terms of removal of waste products and of salt and water are similar to hemodialysis.
- Patients tend to have a more stable biochemical and fluid profile: owing to continuous nature.

Jefferson. University Hospital

PD Exchange Cycle

Diffusion: Waste

Drain Cycle

Infusion: Osmosis

Fill Cycle

Dwell Cycle

- The fluid used typically contains sodium, chloride, lactate or bicarbonate and a high percentage of glucose to ensure hyperosmolarity.

PD Access and Exit Site Care

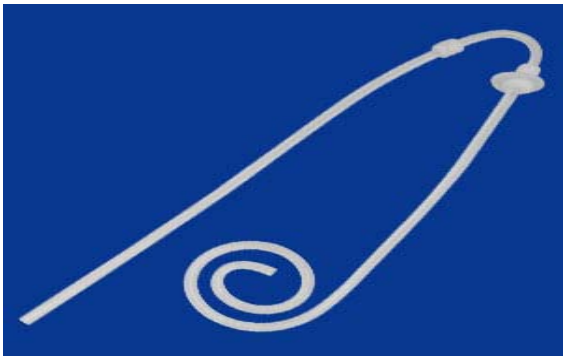
- The key to successful PD is good, permanent and safe access to the peritoneal cavity.
- Infection remains the major source of morbidity and transfer to hemodialysis.
- Excellent catheter and exit site practices are essential in the care of the PD patient.

Jefferson. University Hospital

Infection

- Improvements
  - Flexible silicone rubber from rigid polyvinyl chloride.
  - Swan neck catheters with two downward pointing segments:
  - Coil catheter: aids outflow, less prone to migration
  - Cuffed catheter with microporous material:
  - Silver catheters

Jefferson. University Hospital



PD Catheter

Jefferson. University Hospital

Types of PD Infections

- Exit Site Infection
- Tunnel Infection
- Peritonitis

Jefferson. University Hospital

Peritonitis

Peritonitis is a generalized or localized inflammation of the peritoneum.

- Peritoneal Dialysis
- Colitis
- Appendicitis
- Diverticulitis

Jefferson. University Hospital

Causes of Peritonitis

Intraluminal - infections travel to the peritoneum via the catheter.

Per luminal - – bacteria entering the peritoneum via the peritoneal tract or tunnel.

Tran mural - bacteria enter the peritoneum through the bowel wall.

Hematogenous - infections come from the blood stream.

Transvaginal - organisms can travel through the reproductive tract.

Jefferson. University Hospital

Common Organisms

- Gram Positive:

Organism	Port of Entry	Information
Diptheroids	Intraluminal Periluminal	Normal Skin flora – poor hygiene / break in technique and poor handwashing
Enterococcus	Transmural	Fecal organisms, sometimes hospital acquired – cross contamination
Staphylococcus Aureus	Intraluminal Periluminal	Nasal Carrier
Staphylococcus Epi (Coagulase negative staph)	Intraluminal Periluminal	Due to break in technique (touch contamination)
Streptococcus	Intraluminal Periluminal Hematogenous	Found in soil, water, vegetation and dairy products. Normal GI flora and respiratory tracts

Jefferson. University Hospital

Common Organisms

- Gram Negative:

Organism	Port of Entry	Information
Klebsiella	Intraluminal Periluminal	Normal flora of the GI tract, colonization of the upper respiratory tract
Proteus Species	Intraluminal Periluminal Transmural	Found in soil, water and sewage. Normal fecal flora
Pseudomonas	Intraluminal Periluminal	Found in soil and water
Serratia	Intraluminal Periluminal	Hospital acquired

Jefferson. University Hospital

Common Organisms

- Yeast:

Organism	Port of Entry	Information
Candida Albicans	Intraluminal Periluminal Transvaginal	Diabetes, those on antibiotics at high risk. Moist exit sites

- Mycobacterium:

Organism	Port of Entry	Information
Mycobacterium TB	Hematogenous	Diagnosis: lymphocytes in PD fluid cell count often elevated.

Jefferson. University Hospital

Infected exit site (PD)

Signs and symptoms
- Inflammation at the catheter site
- Redness and pain
- +/- purulent discharge

Jefferson. University Hospital

Photo courtesy of ZJ Twardowski

Tunnel Infection

Photo courtesy of ZJ Twardowski

©ADVANCED RENAL EDUCATION PROGRAM, 2009

©ADVANCED RENAL EDUCATION PROGRAM, 2009

Signs and Symptoms:

- *Redness along tunnel*
- *Purulent discharge*
- *Pain tenderness along tunnel*
- *Abscess over tunnel*
- *Exit site infection and or peritonitis present*

Jefferson. University Hospital

Preoperative Care

- Bath or shower
- Abdominal hair should be clipped
- Bowel should be empty
- Bladder should be empty
- Strict asepsis
- Bactericidal scrub
- Surgeon to create a subcutaneous tunnel

Jefferson. University Hospital

Clinical Presentation of Peritonitis

- Cloudy Effluent
- Abdominal Pain
- Fever
- Acutely declining ultrafiltration

Clinical Diagnosis

- WBC > 100/uL of which at least
- Identification of organism on gram stain or culture
- Abdominal pain
- Cloudy effluent

Jefferson. University Hospital

Peritonitis Key Assessments

- Perform physical exam including abdominal palpation, degree and location of pain, Assess exit-site and tunnel assessment
- Send sample to laboratory for cell count with differential, gram stain and culture.
- In presence of cloudy effluent with pain and/or fever:
  - Initiate empiric antibiotic therapy within one hour while awaiting test results
- In presence of cloudy effluent, add Heparin 500 U/L to new bag until effluent clears (usually 48-72 hours)
- Pain management.

Jefferson. University Hospital

Jefferson. University Hospital

Peritonitis?

Patient Education about Infection and PD

- Immediately report cloudy effluent, abdominal pain and or fever to PD unit,
- Save drained cloudy dialysate and bring to clinic.
- Stress importance of obtaining specimens prior to beginning antibiotics.

Jefferson. University Hospital

Intraperitoneal Antibiotics

- Add intraperitoneal antibiotics for duration of required therapy
- Add heparin 500u/L to each bag until clear
- Report persistent cloudiness to PD unit.
- Schedule retraining for technique issues.

Jefferson. University Hospital

Indications for Catheter Removal

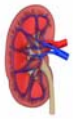
- If they are no longer needed
- In recurrent peritonitis without an identifiable cause
- In peritonitis due to an exit site/tunnel infection
- With an unusual causative organism of peritonitis (fungus, tuberculosis)
- In bowel perforation accompanied by peritonitis
- With persistent and severe pain due either to the catheter impinging on internal organs or during solution inflow
- When there is Dacron cuff erosion and infection

Jefferson. University Hospital

Hemodialysis

Jefferson. University Hospital

Hemodialysis and Infection



- Hemodialysis: treatment used to remove solutes and water from the blood across semi permeable membrane (dialyzer)
- Success of therapy depends almost entirely on the adequacy of the blood flow through the dialyzer.
  - Optimal Clearance of waste depends on:
    - Dialysate flow rate
    - Membrane permeability
    - Membrane surface area
    - Duration of dialysis
    - Blood flow rate

Jefferson. University Hospital

Hemodialysis and Infection

- Dialysis patients are at increased risk for infection for many reasons:
  - Immune Impairments
  - Immune Protection
  - Inflammatory Process
  - Vascular Disease
- Dialysis patients are not only more prone to developing all of these types of viral infections but, when these infections do occur, they tend to be more severe.

Jefferson. University Hospital

Hemodialysis and Infection

- Dialysis patients have an increased incidence of viral and fungal infections (influenza, shingles and hepatitis).
- Fungal infections are more common in dialysis patients than in the general population.

Jefferson. University Hospital

Hemodialysis and Infection

- Patients with kidney failure are more prone to developing urinary tract infections (UTIs):
  - The normal act of passing urine tends to flush out the urinary tract of infectious agents so they cannot gain a foothold and cause problems.
  - Once the kidneys fail and the production of urine is decreased, this normal flushing action is gone (oliguria and anuria).
  - UTIs usually are caused by bacteria which normally inhabit the bowel and spread to the urinary tract by local extension.
  - Patients with renal failure have other urinary tract abnormalities which make them more prone to developing UTIs:

Jefferson. University Hospital

Types of Access

- Percutaneous Access: jugular, subclavian and femoral lines (temporary or permanent)
- Arteriovenous Fistulae (AVF) and Arteriovenous Grafts
  - AVF preferred with ESRD patients: evidence of long term patency, improved flow rates and fewer complications
  - AVF created during surgery to anastomose an artery and a vein
    - Most commonly: Radial artery and the cephalic vein
    - As a result of the anastomosis: blood from the artery is forced into the vein where it flows in a retrograde direction
    - The increased blood flow and pressure cause the vein to thicken and dilate
    - Blood flow up to 800-1000ml/min can be achieved

Jefferson. University Hospital

Inherent Problem

- Hemodialysis catheters are literally infections waiting to happen because they involve:
  1. a foreign body,
  2. a persistent opening through the skin through which bacteria can travel
  3. a patient whose ability to fight infections is impaired.
- As a result, patients with dialysis catheters are strongly encouraged to have a more permanent vascular access, such as a graft or fistula, placed so that the catheter can be removed and the risk of infection decreased.

Jefferson. University Hospital

Sites of Hemodialysis Infections

- Line Infections
- Blood Stream Infections

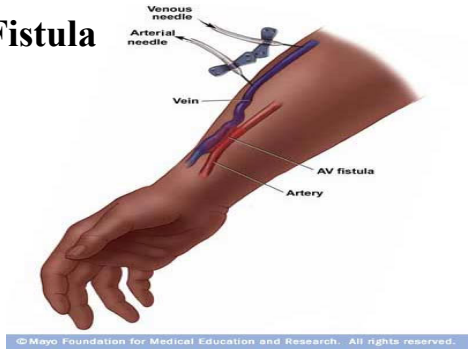
Jefferson. University Hospital

AVF vs. AV Grafts

- AV grafts are less likely to become infected than catheters but, because they are composed of plastic and not natural human tissue, they are more likely to become infected than AV fistulas.
- AV fistulas are the preferred permanent hemodialysis vascular access.
- When AV grafts become infected, it is usually because the formation of a hematoma (leakage of blood usually from a needle puncture site under the skin) has become infected and that infection spreads to the graft material nearby.
- Although an infected hematoma can often be treated effectively with antibiotics, once the infection has spread to the graft material itself, the graft must be removed for the infection to be eradicated.

Jefferson. University Hospital

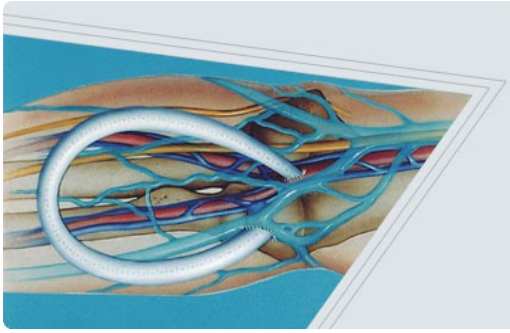
AV Fistula



©Mayo Foundation for Medical Education and Research. All rights reserved.

Jefferson. University Hospital

AV Graft



Jefferson. University Hospital

Infections from HD

- The spread of infectious agents from the dialysis machine or procedure to the kidney patient is unusual in the setting of current infection control policies but does rarely occur.
- Infections related to the dialysis treatment, although unusual, generally occur during the put-on or take-off process.
  - Therefore sterile technique is a fundamental to be used during the beginning and ending of dialysis treatment.

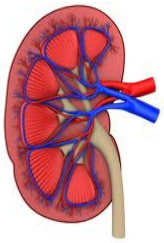
Jefferson. University Hospital

Protection against HD Infections

- The best defense against infection is Education:
  - Be aware of the increased risk and recognize the earliest signs of infections so they can be treated effectively.
  - Many dialysis patients do not develop a fever when they are infected, so it is important to recognize otherwise unexplained symptoms such as unusual fatigue, loss of appetite, nausea, vomiting and changes in mental activity.
  - Dialysis patients should avoid the prolonged use of hemodialysis catheters because they are associated with frequent and serious infections.

Jefferson. University Hospital

QUESTIONS?



Jefferson. University Hospital