

Surgical Infections

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Disclosure

I have no actual or potential conflict of interest in relation to this presentation.

Factors that Increase the Number of Serious Surgical Infection

- Performance of more complicated/longer operations
- Increase in number of geriatric pts
- Use of implants
- Use of immunosuppressive agents
- Laxity of aseptic technique
- Reliance upon prophylactic antibiotic therapy



Classification Of Surgical Infections

- I. Those Relative to Final Outcome
 - Self limiting infections
 - Serious infection
 - Fulminant infection (fatal or permanently disabling)

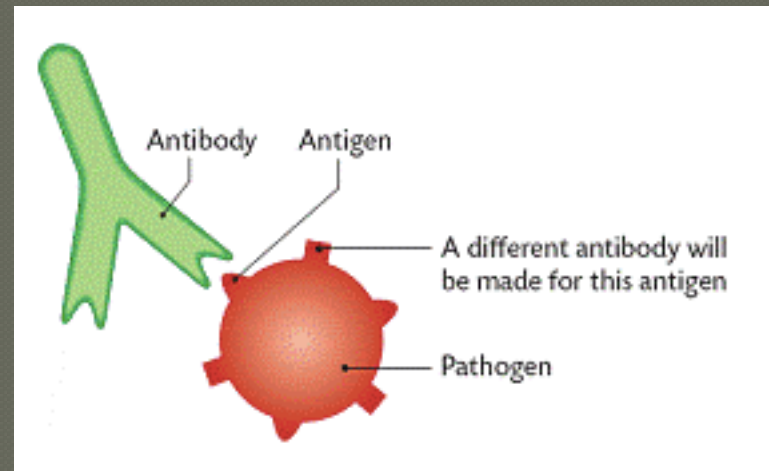
Classification Of Surgical Infections(cont.)

- ◎ II. Those Relative to Time of Onset
 - Pre-operative surgical
 - Operative surgical infection
 - a. Preventable operative surgical infection
 - b. Non-preventable operative surgical infection
 - Post-operative surgical infection (UTI, respiratory, wound)

Determinants Of Infection

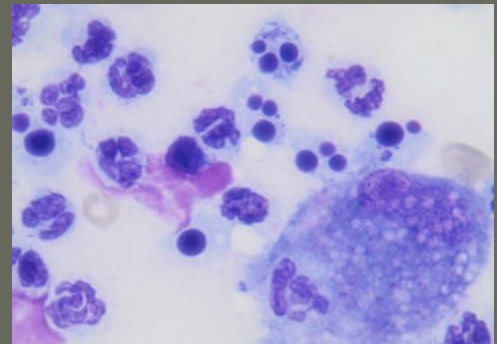
Determinants Of Infection

- A. Microbial Pathogenicity
- B. Host Defenses
 - 1. Local Host defenses
 - 2. Systemic Host defenses
- c. Surgical technique



Microbial Pathogenicity

- ◉ Virulence (tissue invading powers)
- ◉ Infecting dose (10^5)
- ◉ Ability to produce toxins (exotoxins / endotoxins)
- ◉ Ability to resist phagocytosis and intracellular destruction



Host Defenses

◎ Local Host defenses

- Layers of epithelium
- Local environment features
 - Skin lacking of moisture
 - Flushing action of tears & urine
 - Cilia, peristalsis, mucus, pH
- Local immunity IgA



Host Defenses (cont.)

○ Systemic Host defenses

- Decrease delivery of phagocytes
- Diminution in blood flow
- Presence of devitalized tissue, foreign bodies, hematomas and seroma
- Decrease vascular reactivity (uremic, old age, high dose of steroid)
- Decrease production of phagocytes (chemotherapy)



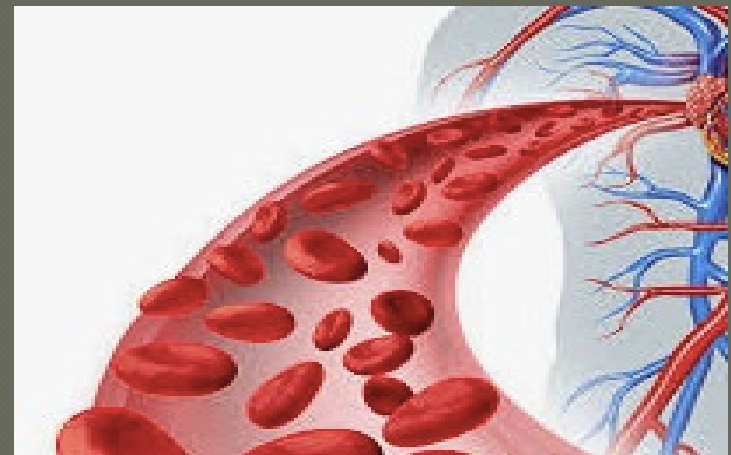
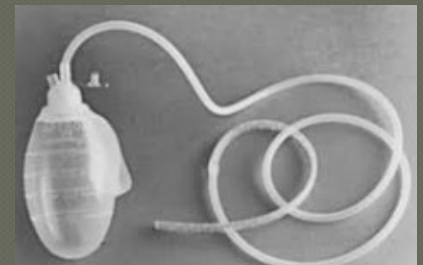
Host Defenses (cont.)

◎ Systemic Host defenses (cont.)

- Abnormal serum factors (opsonins)
 - Specific antibody and complement act as a strong opsonizing agents for phagocytosis of containing bacteria
- Abnormal ingestion & intracellular killing of phagocytes
 - Uremia, ketosis, hyperglycemia, malignancies, severe thermal or traumatic injury, malnutrition, immunosuppression

Surgical technique

- Gentle tissue handling
- Removal of devitalized tissues
- Use of drains
- Avoiding excessive cautery
- Tension free intestinal anastomosis
- Good blood supply



Prevention of Infection

Prevention of Infection

○ Avoidance of Predisposing Conditions

- Bacterial Contamination

- Minimize contamination ----> strict aseptic technique
- Two great sources of microbial contamination:
 - Exogenous contact from breaks in technique by the team
 - Endogenous contamination from patient's skin and various bacteria-containing tracts



Prophylaxis: Preventing Wound Infections

Prophylaxis: Preventing Wound Infections

- ① 1. Avoidance of Bacterial Contamination
- ② 2. Operating Room Team Discipline
- ③ 3. Endogenous
- ④ 4. Importance of Surgical Technique
- ⑤ 5. Systemic Factors
- ⑥ 6. Reduction of Colonic Bacteria
- ⑦ 7. Prophylactic Antibiotics

Avoidance of Bacterial Contamination

- ① 1. Environmental factors
- ② 2. Pre-operative preparations of the patient
- ③ 3. Skin preparation

Avoidance of Bacterial Contamination (cont.)

◉ Environmental factors

- Avoid exogenous and endogenous contamination
- UV light and laminar flow ventilation
- Limitation of traffic in and out of the OR
- Limitation of activity and talking in the OR



Avoidance of Bacterial Contamination (cont.)

Pre-operative preparations of the patient

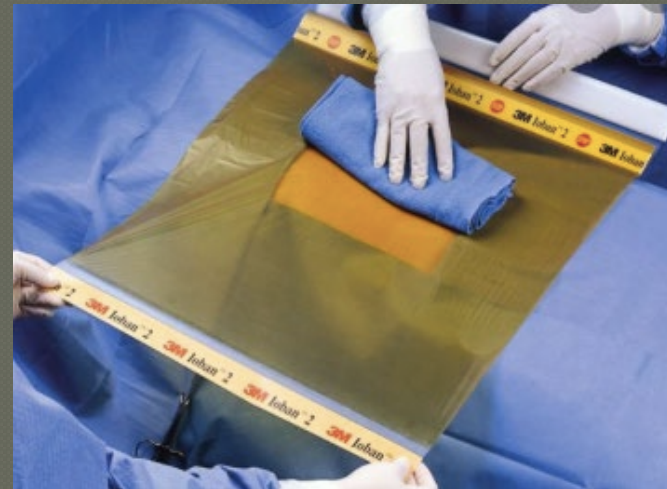
- Pre-operative shower w/ antimicrobial soap (chlorhexidine)
- Cutaneous infection should be cleared before elective operation
- Hair removal
 - promotes bacterial growth to 100% if the blade cuts the skin
 - studies showed that shaving increases infection rate to 5.6% from 0.6%



Avoidance of Bacterial Contamination (cont.)

○ Skin preparation

- Scrub the operative area for 5-7 min with germicidal solution and paint w/ providine-iodine or chlorhexidine
- Use an antimicrobial incision drape



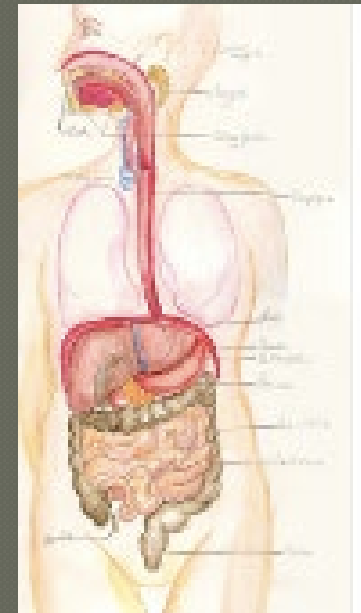
Operating Room Team Discipline

- Wear clean scrub suits, cap and masks
- Scrub hands and forearms w/ antimicrobial soap
- Careful dressing and wearing of gowns and gloves
- Change punctured or torn gloves



Endogenous Contamination

- Avoid bacterial contamination of the surgical wound at the time of transection of the GI system, GU system, and respiratory tract

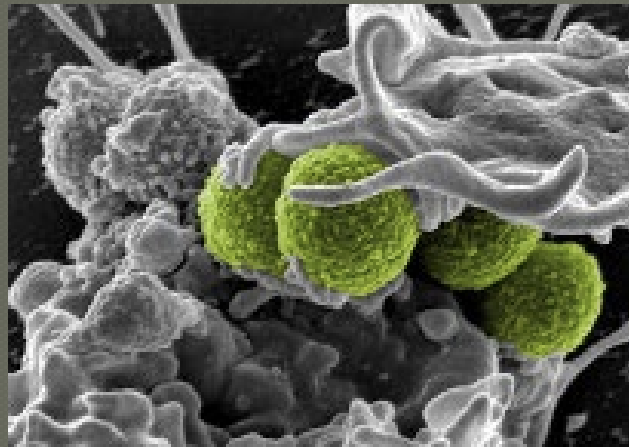


Importance of Surgical Technique

- Gentle care of the tissues to minimize local damage
- All devitalized tissue and foreign bodies should be removed
- Use monofilament sutures for potentially infected wound
- Avoid the development of hematomas, seromas and dead spaces
- Role of delayed primary closure (tertiary wound healing)

Systemic Factors

- ◉ Host resistance (control systemic diseases)
- ◉ Correct malnutrition
- ◉ Avoid disturbance of circulation
- ◉ Avoid unnecessary use of drugs



Reduction of Colonic Bacteria (Intestinal Antisepsis)

- ◉ Reduce the high rate of infectious complication after colorectal surgery
- ◉ Mechanical cleansing of the colon
 - Nichols-Condon Method
 - 2 days fluid diet, mechanical
 - Oral methronidazole and erythromycin
 - Whole gut irrigation
 - polyethylene-glycol-electrolyte lavage (GOLYTELY)
 - Miralax prep
 - 238g in 64oz fluid



Prophylactic Antibiotics

- Given IV 30 – 60 mins before operation so that adequate blood and tissue levels are present at the time that the skin incision is made
- Another dose given if operating time is > 4hrs and a third dose given w/in 24 hrs
- Principles regarding choice of abx:
 - Choose antibiotic effective against pathogens most likely to be encountered
 - Low toxicity
 - Utilization of host defenses to augment antimicrobial effect of the antibiotics

Surgical Site Infections

Surgical Site Infections

- Infections of the tissues, organs, or spaces exposed by surgeons during performance of an invasive procedure
- SSIs are classified into:
 - 1. Incisional
 - superficial (limited to skin and subcutaneous tissue)
 - deep incisional categories
 - 2. Organ/space infections



Surgical Site Infections (cont.)

○ Factors:

- 1. Degree of microbial contamination of the wound during surgery
- 2. Duration of the procedure
- 3. Host factors
 - diabetes, malnutrition, obesity, immune suppression, etc.



Risk Factors for Development of Surgical Site Infections

○ A. Patient factors

- Immunosuppression
- Diabetes mellitus
- Chronic inflammatory process
- Malnutrition
- Peripheral vascular disease
- Anemia
- Radiation
- Chronic skin disease
- Carrier state (e.g., chronic Staphylococcus carriage)
- Recent operation

Risk Factors for Development of Surgical Site Infections(cont.)

● B. Local Factors

- Poor skin preparation
- Contamination of instruments
- Inadequate antibiotic prophylaxis
- Prolonged procedure
- Local tissue necrosis
- Hypoxia
- Hypothermia



● C. Microbial factors

- Prolonged hospitalization (nosocomial organisms)
- Toxin secretion
- Resistance to clearance (e.g., capsule formation)

Classification Of Surgical Wounds According to Risk of Infection

- Class I: Clean
- Class II: Clean-contaminated
- Class III: Contaminated
- Class IV: Dirty/Infected

Class I: Clean Wound

- 1.5 – 5.4% infection rate
- Elective cases
- Primarily closed and undrained wounds
- Nontraumatic, uninfected, no inflammation
- No break in asepsis
- Respiratory, alimentary, genitourinary or oropharyngeal tracts not entered
- Eg: hernia repair, breast biopsy

Class II: Clean-Contaminated Wound

- ◉ 2.1 – 9.5% infection rate
- ◉ Alimentary, respiratory, genito-urinary tract entered under controlled conditions and w/o unusual contamination
- ◉ Minor break in technique
- ◉ Mechanical drainage
- ◉ Eg: appendectomy, biliary tract (gallbladder)

Class III: Contaminated Wound

- ◉ 3.4 – 13.2% infection rate
- ◉ Open, fresh traumatic wound
- ◉ Gross spillage from gastrointestinal tract
- ◉ Entrance of GU or biliary tract in presence of infected urine/bile
- ◉ Major break in technique
- ◉ Eg: penetrating abdominal trauma, large tissue injury, enterotomy during bowel surgery

Class IV: Dirty/Infected Wound

- 28 – 40% infection
- Traumatic wound w/ retained devitalized tissue, foreign body, fecal contamination or delayed treatment
- Perforated viscus encountered
- Acute bacterial inflammation w/ pus encountered during operation

Surgical Management of Wounds

○ Class I and II wounds

- may be closed primarily

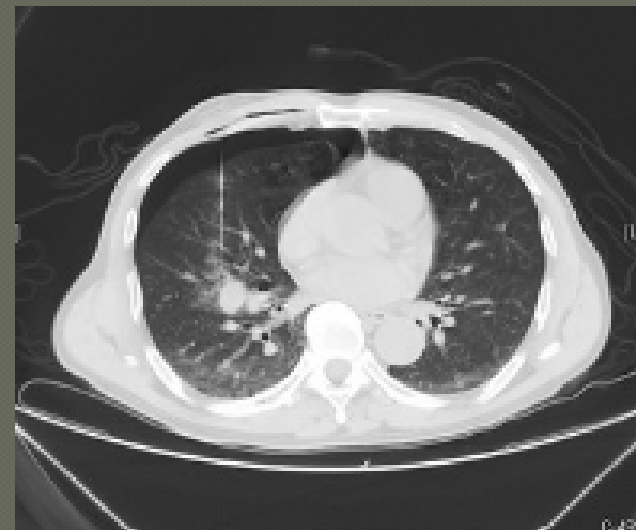
○ Class III and IV wounds

- skin closure is associated w/ high rates of incisional SSIs (25-50%)
- should be packed open and allowed to heal by secondary intention
- selective use of delayed primary closure has been associated with a reduction in incisional SSI rates

Diagnosis and Treatment of Surgical Infection

Diagnosis and Treatment of Surgical Infection

- Careful history and Physical Exam
- Laboratory and radiological techniques:
 - Urinalysis, CBC, blood culture and sensitivity
 - Ultrasonography / CT scan / MRI



Diagnosis and Treatment of Surgical Infection(cont.)

○ If pus present on exam:

- Color, odor and consistency can differentiate different organisms:
 - Foul odor – Anaerobic
 - Greenish - *P. aeruginosa*
 - Creamy - *S. aureus*
 - Thin watery - Strep / clostridium



Diagnosis and Treatment of Surgical Infection(cont.)

- Antibiotic treatment based on culture and sensitivity
- Surgical Intervention
 - Incision and drainage of localized abscess
 - Adequate debridement of necrotic tissue Removal of hematoma, seroma and foreign bodies
 - If dead space consider use of sterile closed-suction tube
- Appropriate wound care and dressing changes



Types of Surgical Infections

Types of Surgical Infections

- ① 1. Soft tissue infections
 - Cellulitis, Erysipelas, Lymphangitis
 - Soft tissue abscess
 - Necrotizing soft tissue infections
 - Tetanus

Types of Surgical Infections

- ② 2. Body cavity infections
 - Peritonitis and intra-abdominal abscess
 - Primary peritonitis
 - Secondary bacterial peritonitis
 - Tertiaryary peritonitis

Types of Surgical Infections

- ③ 3. Prosthetic-device or implant associated infections
 - Joint replacement
 - Mesh

- ④ 4. Hospital acquired infection
 - Wound infection
 - UTI
 - Pneumonia

Soft Tissue Infections

- ① 1. Cellulitis, Erysipelas, Lymphangitis
 - Erythema, local pain & tenderness, edema
 - Fever, chills, malaise, and toxic reaction
 - Pathogens:
 - *S. pyogenes*
 - *S. aureus*
 - *S. pneumoniae*
 - *H. influenzae*
 - Aerobic and anaerobic gram
 - Treatment:
 - Antibiotic, immobilization/elevation and hygiene

cellulitis



erysipelas



lymphangitis



Soft Tissue Infections (cont.)

②. Soft tissue abscess

- Furunculosis, felon, carbuncle
- Treatment:
 - Incision and drainage
 - Antibiotic, hygiene, and nutrition



Soft Tissue Infections (cont.)

③ 3. Necrotizing Soft Tissue Infections

- Necrotizing fasciitis, gas gangrene, clostridium myonecrosis, Fournier's gangrene
- Mixed aerobic/anaerobic gram neg and gram + bacteria (and fungi)
- Pts at risk
 - elderly, immunosuppressed, diabetic, PVD
- Infection compromises fascial blood supply which is coupled w/ introduction of exogenous microbes
- Most commonly affects extremities, perineum, trunk, and torso

Soft Tissue Infections (cont.)

● Necrotizing Fasciitis Manifestations

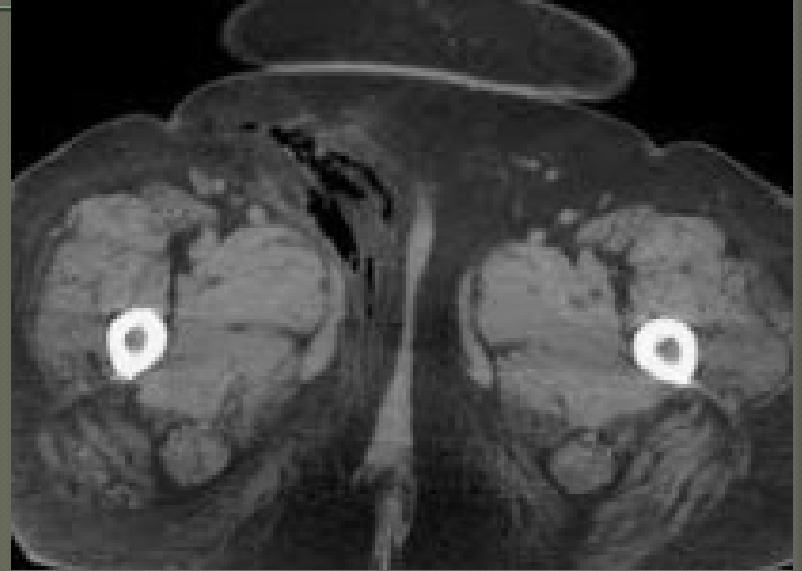
- Small break or sinus in skin from which grayish, turbid semipurulent material (“dishwater pus”) can be expressed
- Skin changes (bronze hue or brawny induration), blebs, or crepitus
- Pain out of proportion to physical exam
- Sepsis or septic shock

Soft Tissue Infections (cont.)

● Necrotizing Fasciitis Treatment

- Debridement of necrotic tissue (amputation)
- Reconstruction/plastic surgery once infection is controlled
- Antimicrobial agents directed against gram + and gram-negative aerobes and anaerobes (e.g., vanco plus carbapenem), and high-dose PCN-G (clostridial pathogens)
- Abx refined based on culture/sensitivity

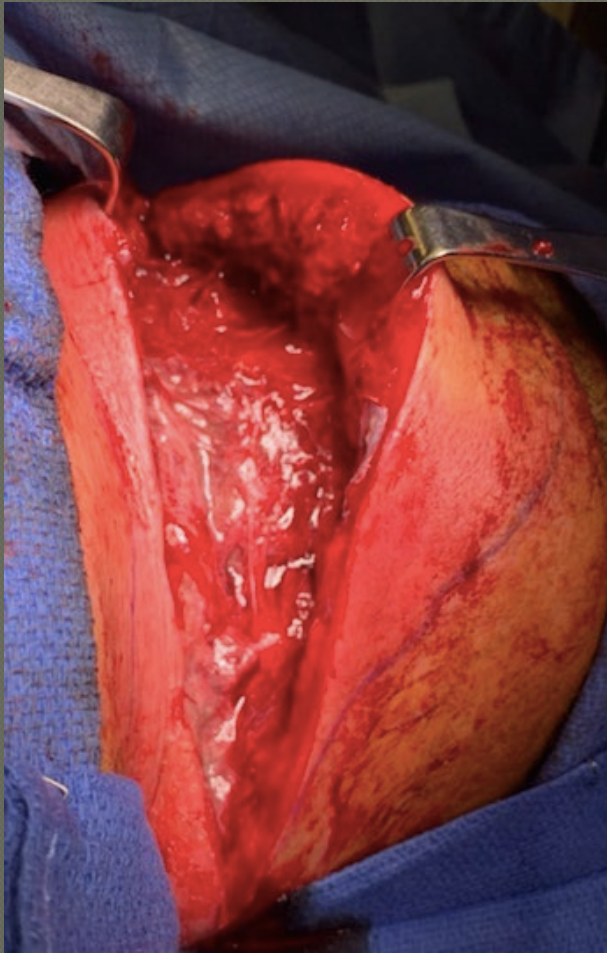
fourniers gangrene



necrotizing fasciitis



necrotizing fasciitis



necrotizing fasciitis



Soft Tissue Infections (cont.)

● 4. Tetanus

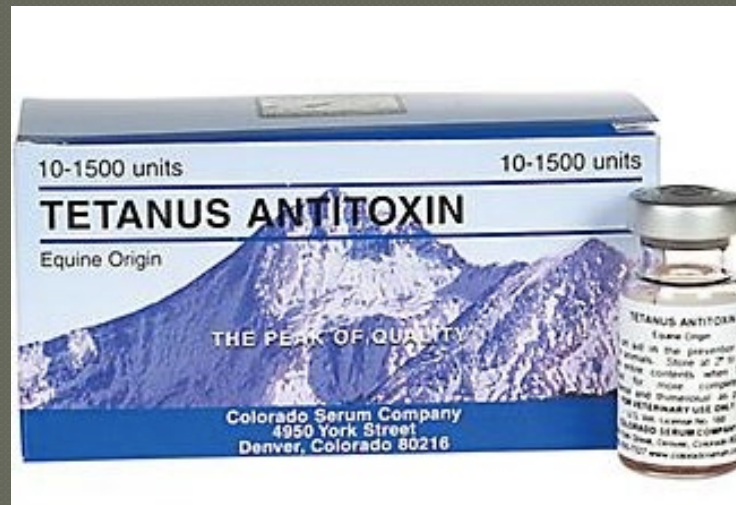
- Clostridium tetani
 - Produces endospores which release toxins
 - Tetanospasmin – neurotoxin that acts on anterior horn cells of spinal cord and brain stem by blocking inhibitor synapses (anaerobic environment)
 - Tetanolysin - cardiotoxicity and hemolysis
- Symptoms:
 - Restlessness, headache, stiff neck
 - Orthotonus (rigidity), opisthotonus (backward arching), convulsions



Soft Tissue Infections (cont.)

○ Tetanus Treatment

- Tetanus immune globulin (TIG)
 - Immediate, short-term protection
- Tetanus antitoxin
 - Immediate passive immunity that lasts 7-14 days



Soft Tissue Infections (cont.)

● Tetanus Treatment (cont.)

- ICU admission
 - sedation, respirator if needed, intense nursing care
- Wound debridement
- Penicillin G Na
- Muscle relaxant, analgesic, nutrition, laxatives, pressure sore precautions, eye protection



Body Cavity Infections

○ Primary Peritonitis

- Single organism
- Microbes invade normally sterile confines of peritoneal cavity
 - hematogenous dissemination from distant source of infection
 - direct inoculation
- More common among pts w/ ascites and those tx for ESRD via peritoneal dialysis



Body Cavity Infections (cont.)

○ Primary Peritonitis Diagnosis

- Dx established based on identification of risk factors
 - Physical examination
 - diffuse tenderness and guarding w/o localized findings
 - Absence of pneumoperitoneum
 - Leukocytosis
 - Microbes with single morphology on Gram's stain performed on fluid via paracentesis

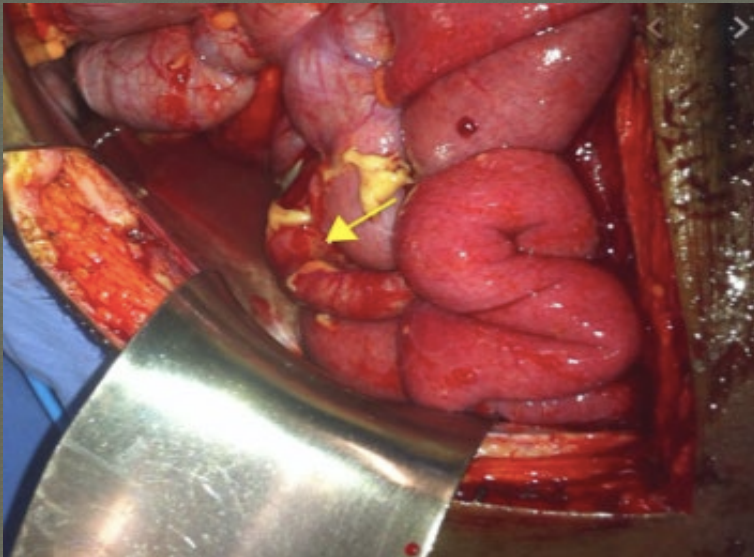
Body Cavity Infections (cont.)

◎ Primary Peritonitis Treatment

- Administration of organism-sensitive antibiotic (14-21 days)
- Removal of indwelling devices (e.g., PD catheter, peritoneovenous shunt) usually required

Body Cavity Infections (cont.)

- **Secondary bacterial peritonitis**
 - Secondary to perforation or rupture of hollow viscus
 - Ruptured appendicitis, perforated duodenal ulcer, perforated gallbladder, perforated diverticulitis

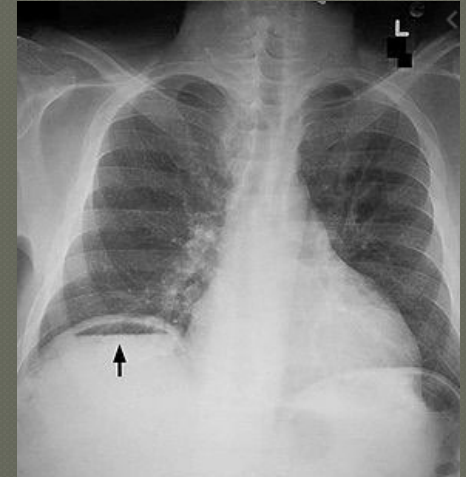


Body Cavity Infections (cont.)

● Secondary bacterial peritonitis

- Diagnosis

- Physical exam, labs, vitals
- Imaging (US, CT scan)

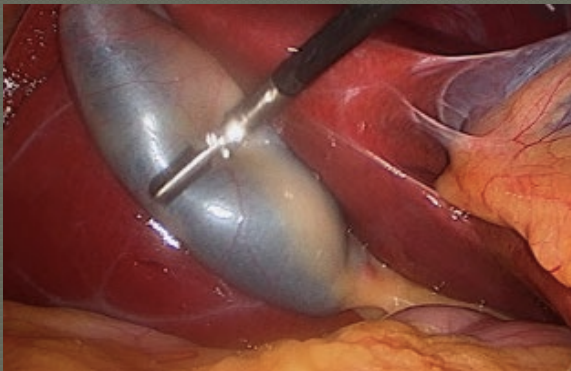
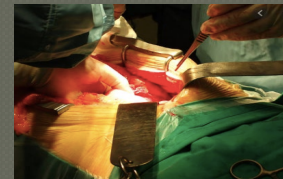


Body Cavity Infections (cont.)

● Secondary bacterial peritonitis treatment

- Surgical intervention

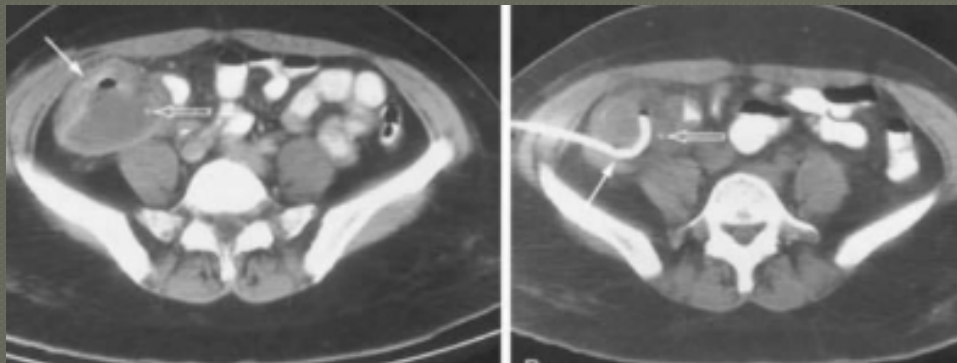
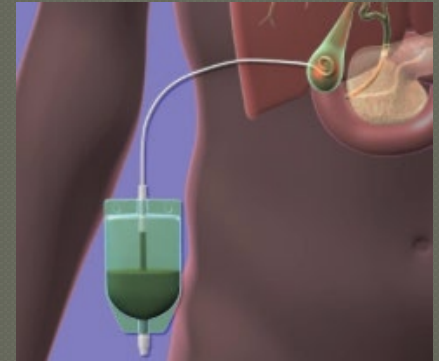
- remove the diseased organ
- debridement of necrotic, infected tissue and debris
- Indicated if multiple abscesses, abscesses in proximity to vital structures, or if ongoing source of contamination is identified



Body Cavity Infections (cont.)

○ Secondary bacterial peritonitis treatment

- Percutaneous drainage under imaging
 - less-invasive
 - option for poor operative candidates
 - pt may still eventually need surgery
 - drainage catheter remains in situ until:
 - it is clear that cavity collapse has occurred
 - output <10-20 mL/day
 - no evidence of ongoing source of contamination
 - Most importantly, patient's clinical condition has improved



Body Cavity Infections (cont.)

● Secondary bacterial peritonitis

- Post-treatment management
 - Combination of antibiotic agents or single broad spectrum agent
 - Conversion of parenteral to oral abx regimen only when ileus resolves (ileus expected)
 - Effective source control and abx therapy is associated w/ mortality rate of 5 to 6%
 - Inability to control source of infection leads to mortality >40%.

Body Cavity Infections (cont.)

● Tertiary peritonitis

- Poorly understood
- More common in immunosuppressed patients
 - peritoneal host defenses do not effectively clear or sequester initial secondary microbial peritoneal infection
- Associated with mortality rates >50%

Prosthetic Device – Associated Infections

- ◉ Frequently eradicated after removal of foreign body
- ◉ Joint prosthetic infections
- ◉ Mesh infections
 - If mesh is used in a contaminated case (exogenous or endogenous source)
 - Usually requires re-operation and mesh removal
 - If necessary to use mesh in a contaminated case, biologic mesh is a better choice

Prosthetic Device – Associated Infections



Hospital – Acquired Infection

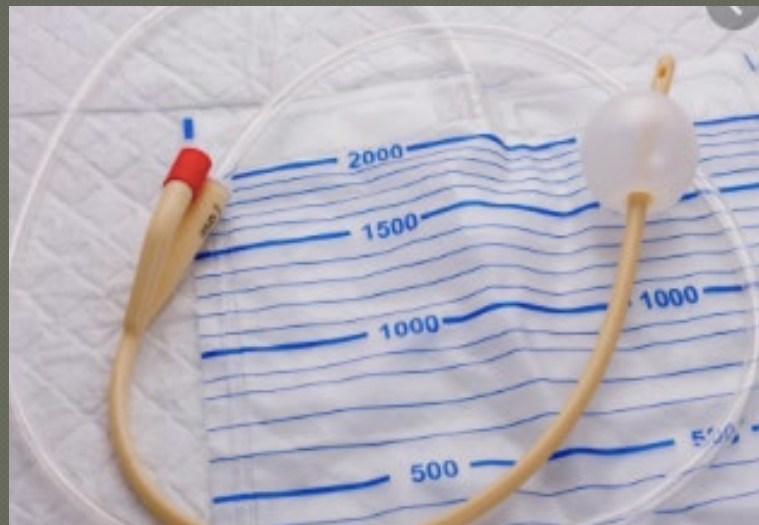
- ◎ **Wound infection**
 - Decubitis ulcer infection
 - Surgical site infection
- ◎ **Urinary tract infection (most common)**
 - Usually related to Foley catheter
- ◎ **Lower respiratory tract infection**
- ◎ **Vascular catheter-related infection**

Hospital – Acquired Infection

(cont.)

◎ Nosocomial Infections

- Infections related to prolonged use of indwelling tubes and catheters for the purpose of urinary drainage, ventilation, and venous or arterial access



Hospital – Acquired Infection

(cont.)

● Nosocomial Infections

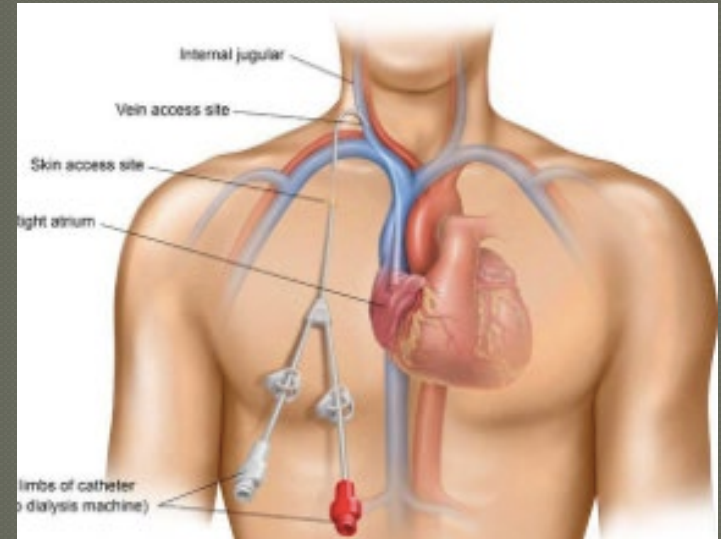
- 1. UTI
 - Abx tx for 10-14 days
 - Indwelling urinary catheters to be removed as quickly as possible
- 2. Mechanical ventilation
 - Increased incidence of pneumonia
 - X-ray evidence of pulmonary consolidation
 - Broncho-alveolar lavage for Gram's stain & culture
 - Surgical pts should be weaned from mechanical ventilation as soon as feasible

Hospital – Acquired Infection

(cont.)

◎ Nosocomial Infections

- 3. Intravascular catheter infection
 - Prolonged insertion
 - Insertion under emergency conditions
 - Sterile technique is usually compromised
 - Manipulation under non-sterile conditions
 - Site of insertion
 - Femoral vs. Internal Jugular or Subclavian



Asepsis

Asepsis

○ Surgical Asepsis

- Prevention of access of microorganisms to an operative wound
- To destroy and remove bacteria (and other pathogens) from all objects coming in contact with the wound

Asepsis (cont.)

○ Antiseptic

- Chemical agents that either kill or inhibit growth of bacteria when applied to human tissues

○ Disinfectant

- Germicidals applied to inanimate objects

○ Sterilization

- A process of killing all microorganisms



Aseptic Technique

- Hygienic hand washing
- Pre-operative prep of patient's skin
- Use of sterile gloves and gown
- Application of sterile drapes
- Isolation precautions
- Sterilization (autoclave or other method) of instrument(s) that will be used
- Proper waste disposal



The Operating Room

- Ideally, the OR is free from bacterial contamination
- Minimize personnel inside OR



The Operating Room

○ Appropriate ventilation

- Laminar flow
 - High momentum diffusion and low momentum convection
 - No or minimal crossover of air streams
- Air passes through filter that efficiently removes bacteria and fungi (but not viruses)
- Doors should remain closed except as needed
- Positive pressure in the OR



The Patient

- The patient is the most common source of contamination in the OR
- Preparation of patient's skin
 - Preoperative showering
 - Hair removal
 - only at operative sites
 - done in OR
 - clippers, not razors
 - Application of antiseptic to patient's skin
 - Povidone iodine – active to bacteria, fungi and viruses
 - Application of sterile drapes



The OR Team

- ◉ Minimize the number of people inside the room
- ◉ Proper scrubbing and attire
- ◉ Sterile gloves and gown
 - Gloves protect patient from surgeon's hands
 - Gloves protect the doctor from contaminated blood/body fluids



In Conclusion:

- Most surgical infections are easily treated if detected early
- More importantly, prevention techniques significantly decrease incidence
- Surgical site wounds are also preventable, but even in the most careful situations they may still occur
- The key to adequate treatment, again, is early detection and prompt treatment