Infection associated with medical devices

Health care associated infections (HAIs) (called Nosocomial infections previously) are infections that patients acquire while receiving treatment for medical or surgical conditions within the health care system. HAIs account for an estimated 1.7 million infections and 99,000 associated deaths each year. HAIs affect 5 to 10% of hospitalized patients annually. Device-related infection results from the introduction of organisms, primarily bacteria, during the device insertion or implantation procedure, or from attachment of bloodborne organisms to the newly inserted device and their subsequent propagation on its surface.

Many factors play an important role in the acquisition of the infections including:

1. Susceptibility of the host.
2. Composition of the device.
3. Ability of the microorganism to adhere to the device itself or to the biofilm that quickly forms.
4. Prematurity
5. Immunodeficiency and neutropenia.
6. Burn and other skin disorders
7. Environmental factors.

It may be caused by bacteria, viruses, fungi, or parasites. These infectious organisms or "germs" may come from:

- Environmental sources (dust, medical equipment, doorknobs, etc.)
- Other patients
- Staff members
- Hospital visitors

An implanted medical device includes:

1. **Intravascular**
   - Peripheral catheters (venous, arterial)
   - Midline catheters
   - Central venous catheters
   - Non-tunnelled catheters (Cook, Arrow)
   - Tunnelled catheters (Hickman, Broviac, Groshong)
   - Pulmonary artery catheters
2. **Cardiovascular**
   - Mechanical heart valves
   - Implantable defibrillators and related devices
   - Vascular grafts
   - Ventricular assist devices
   - Coronary stents
   - Implantable patient monitors

3. **Neurosurgical**
   - Ventricular shunts
   - Intracranial pressure devices
   - Implantable neurological stimulators

4. **Orthopaedic**
   - Joint prostheses and other reconstructive orthopaedic implants
   - Spinal implants
   - Fracture-fixation devices

5. **Urological**
   - Inflatable penile implants
   - Urinary catheters

6. **Gynaecological**
   - Breast implants

7. **Otolaryngological**
   - Cochlear implants
   - Middle ear implants

8. **Ophthalmological**
   - Intra-ocular lenses
   - Glaucoma tubes

9. **Dental**
   - Dental implants

10. **Others….**
Vascular device infections:
Vascular catheters:
Short, peripheral IV catheters used for short term access in stable patients are associated with a lower rate of infection.
Peripherally inserted central catheters are commonly used for short term venous access.
Central catheters are commonly placed for extended venous access (for chemotherapy, Hickman catheters) by surgical procedures passed through subcutaneous tunnel. It carries higher rate of infection which can be diagnosed by culture.

Septic thrombophlibitis is thrombosis with organisms embedded in the clot.
Catheter related blood stream infection implies isolation of the same organism from the catheter and from peripheral blood of a patient with clinical symptoms of bacteremia and no other apparent source of infection.
Infection may appear as an exit site infection or may extend along the catheter tunnel causing tunnel infection.
Common organisms causing infections are; Staph. Aureus (in about 50% of cases), CONS, Enterococcus and candidia. Other skin flora, diphtheroid and bacillus are often involved. Gram negative organisms cause 20-40% of infection.
Polymicrobial infections of central venous catheters are also common.
Rate of infection are about 2 per 1000 catheter days.
Infection rate are lower for tunneled and implanted catheters. Catheters inserted in emergency situation carry higher risk than catheters place electively.

Clinical features of the infection ranges from mild fever to overwhelming sepsis.
Infections at exit site manifests as localize cellulitis with warmth, tenderness, swelling, erythema and discharge.
Tunnel infection manifests warmth, erythematous tender palpable cord at the IV site.
Treatment of infection depends on the site of infection and the pathogen involved.
Catheters that are no longer necessary should be removed.
Catheter associated bacteremia can be managed by simple catheter removal, removal plus antibiotic or an attempts of antibiotic alone.
Initial antibiotics should cover both Gram +ve and Gram –ve organisms (Cephalosporin plus oxicillin, naficillin or vancomucin). 10-14 days usually needed for the treatment.
Catheter removal is indicated in case of sepsis, septic thrombophlibitis, persistant +ve blood culture despite appropriate therapy after 48-72 hr., embolic lesions or fungal infection.
Antibiotic lock is a method of sterilizing intravascular catheters by using high concentration of antibiotics infused into the portion of the catheter between the hub and the vessel entry.
**Ventilator associated pneumonia:**

Intubation of the airway bypasses the normal host defenses and produce infection. Contaminated respiratory equipments, humidification systems, or condensate introduces bacteria directly to the lungs. Open upper airway increases risk of aspiration of oropharyngeal flora and reflux of gastric contents and interferes with clearance if airway by coughing. Suctioning of the upper airway or cleaning the endotracheal tube requires clean aseptic technique and by using disposable close suction system for endotracheal tube are important measures to decrease rate of infection.

**Urinary catheter:**

It's one of the commonest HAI and it’s the most common medical device used. Urinary-tract infections occur in about 20% of patients with Foley catheters in place for more than 10 days; and in more than 40% of patients with Foley catheters in place for more than 25 days.

Organisms enter the bladder through the catheter by instillation of contaminated irrigation fluids, back flow of contaminated urine from the drainage bag, or ascent of bacteria around the meatus.

Common organisms causing infection are the gram –ve bacteria including; E. coli and Enterococcus.

Minimizing the duration of catheterization (use of sliver alloy Catheter), intermittent catheterization, choosing smallest gauge fit to the patient and aseptic techniques are important measures to minimize infection.

Catheter should be placed in fully aseptic technique and the drainage bag should be closed all time, dependent to prevent urine back flow below the level of bladder, it should not be put on the ground and emptied regularly and the urinary meatus must be washed with soap and water.

**Peritoneal Dialysis associated infections:**

Indwelling catheter may be complicated by exit site infection, tunnel infection, and peritonitis. usually infection starts from skin to the peritoneum.

Common pathogens are skin flora like Staphylococcus, Pseudomonas, Acinebacter, and enteric flora; such as E. coli and Klebsiella and fungi like C. Albicans.

Peritonitis presents with abdominal pain, fever and cloudy dialysate. Diagnosis is confirmed by culturing dialysate.

Prevention of infection is by careful planning of the exit site location, aseptic insertion technique, meticulous care of catheter site, securing of the catheter to avoid tension and motion, and aseptic technique during dialysis.
Central nervous system catheter related infections:

The usual procedure uses a silicone rubber device with a proximal portion inserted into the ventricle, a unidirectional valve, and a distant segment that diverts the CSF from the ventricles to either the peritoneal cavity (ventriculoperitoneal [VP] shunt) or right atrium (ventriculoatrial [VA] shunt).

The incidence of shunt infection ranges from 1 to 20%, with an average of 10%. The highest rates are reported in young infants. Most infections are a result of intraoperative contamination of the surgical wound by skin flora. Accordingly, coagulase-negative staphylococci are isolated in more than half of the cases. Staphylococcus aureus is isolated in approximately 20% and gram-negative bacilli in 15%.

Four distinct clinical syndromes have been described: colonization of the shunt, infection associated with wound infection, distal infection with peritonitis, and infection associated with meningitis.

The most common type of infection is colonization of the shunt with symptoms that reflect shunt malfunction as opposed to frank infection. Symptoms associated with colonized VP shunts include lethargy, headache, vomiting, and a full fontanel. Low-grade fever is common.

Wound infection presents with obvious infection or dehiscence along the shunt tract. S. aureus is the most common isolate.

Distal infection of VP shunts with peritonitis presents with abdominal symptoms, usually without evidence of shunt malfunction. Gram-negative isolates predominate and mixed infection is common.

The usual meningeal pathogens, Streptococcus pneumoniae, Neisseria meningitidis, and Haemophilus influenzae type b, can also cause bacterial meningitis in patients with shunts in place. The clinical presentation is similar to that for acute bacterial meningitis.

Treatment of shunt colonization and distal infection with peritonitis includes the use of antibiotics against the specific organisms isolated and, in most situations, removal of the shunt. Intrashunt antibiotics are indicated because of the poor penetration of most antibiotics into the central nervous system across uninflamed meninges. The best treatment success occurs with initial systemic and intrashunt antibiotics in combination with exteriorization of the distal end of the shunt. When wound infection is diagnosed, the shunt almost always needs to be removed.

Prevention of shunt infection includes meticulous cutaneous preparation and surgical technique. Systemic and intraventricular antibiotics, antibiotic-impregnated shunts, and soaking the shunt tubing in antibiotics have been used to reduce the incidence of infection.