



Module 3 Device associated Health care infections

Session 1



Objectives

By the end of this module, you will be able to be able to:

- Define the major device-associated HAIs
- Describe the common HAIs in health care settings
- Discuss the care bundles for prevention of common HAIs



Introduction

- With many medical equipment in hospitals coming in direct contact with healthcare workers, patients, technicians, cleaners and sometimes care givers, it is important to pay close attention to their capacity in harboring potentially harmful pathogens
- Medical devices include all the health technologies (except for vaccines and medicines) required for prevention, diagnosis, treatment, monitoring, rehabilitation and palliation. They are indispensable for universal health coverage, monitoring wellbeing and addressing outbreaks or emergencies.



Some types of medical devices

- single use devices (i.e. syringes, catheters)
- implantable (i.e. hip prosthesis, pacemakers)
- imaging (i.e. ultrasound and CT scanners)
- medical equipment (i.e. anesthesia machines, patient monitors, hemodialysis machines)
- software (i.e. computer aided diagnostics)
- in vitro diagnostics (i.e. glucometer, HIV tests)
- personal protective equipment (i.e. mask, gowns, gloves)
- surgical and laboratory instruments



The role of medical devices in infection spread

- Medical devices are responsible for a large portion of nosocomial infections, particularly in critically ill patients.
- Device-associated infections can cause major medical and economic sequelae. Bacterial colonization of the indwelling device can be a prelude to both infection and malfunction of the device.
- The pathogenesis of device-associated infection centers around the multifaceted interaction among the bacteria, the device, and the host.
- Bacterial factors are probably the most important in pathogenesis of infection, whereas device factors are the most amenable to modification with the objective of preventing infection.



• **Central Line-Associated Blood Stream Infection (CLABSI)**



Introduction

- Blood stream infections (BSIs) are associated with the use of **intravascular catheters**
- CLABSIs (Central Line Associated Blood Stream Infections) are associated with increased morbidity, mortality rates, prolonged hospitalization and increased medical costs
 - 35% attributable mortality
 - BSIs lead to excess hospital length of stay of approximately 24 days



cont.

- Central Line (CL) use is a major risk factor for BSI
- Although a 46% decrease in CLABSI has occurred in hospitals across the U.S. from 2008-2013, an estimated 30,100 (2011) CLABSI still occur in intensive care units and wards of U.S. acute care facilities each year
- Rates of CLABSI appear to vary by type of catheter



Central Lines

- Different factors contribute to the onset of CLABSI and those include Multiple catheters and/or multiple lumens, Emergency insertion, Prolonged duration of central venous catheter (CVC), Prolonged hospital stay prior to CVC insertion, Excessive manipulation of the catheter, Neutropenia, Prematurity, Total parenteral nutrition (TPN).



Cont.

- Blood stream infections are caused by many different pathogens which include Coagulase-negative staphylococcus (*Staphylococcus epidermidis*), Candida species, Enterococci, Staphylococcus aureus



Pathogenesis of CLABSI

- **More common mechanisms**
- The patients could be affected through different ways which include Extra luminal where Pathogens migrate along external surface of catheter and it is more common in early period following insertion, < 7 days and Intraluminal way where Hub contamination, migration along internal surface can cause the CLABSI and it is more common >7 days, intraluminal colonization.



Cont.

- However, they may appear in the following ways though it is not common and those include Hematogenous seeding from another source and Contaminated infusate



CLABSI Definition

- Primary bloodstream infection, in a patient with a central line that was in place for >2 calendar days on the date of event, with day of device placement being **Day 1** and is not related to infection at another site



CLABSI Risk Factors

- Multiple catheters and/or multiple lumens
- Emergency insertion
- Prolonged duration of central venous catheter (CVC)
- Prolonged hospital stay prior to CVC insertion
- Excessive manipulation of the catheter
- Neutropenia
- Prematurity
- Total parenteral nutrition (TPN)



Common CLABSI Pathogens

Blood stream infections are caused by many different pathogens, including:

- Coagulase-negative staphylococci
 - *Staphylococcus epidermidis*
- Candida species
- Enterococci
- *Staphylococcus aureus*



Pathogenesis of CLABSI

More common mechanisms

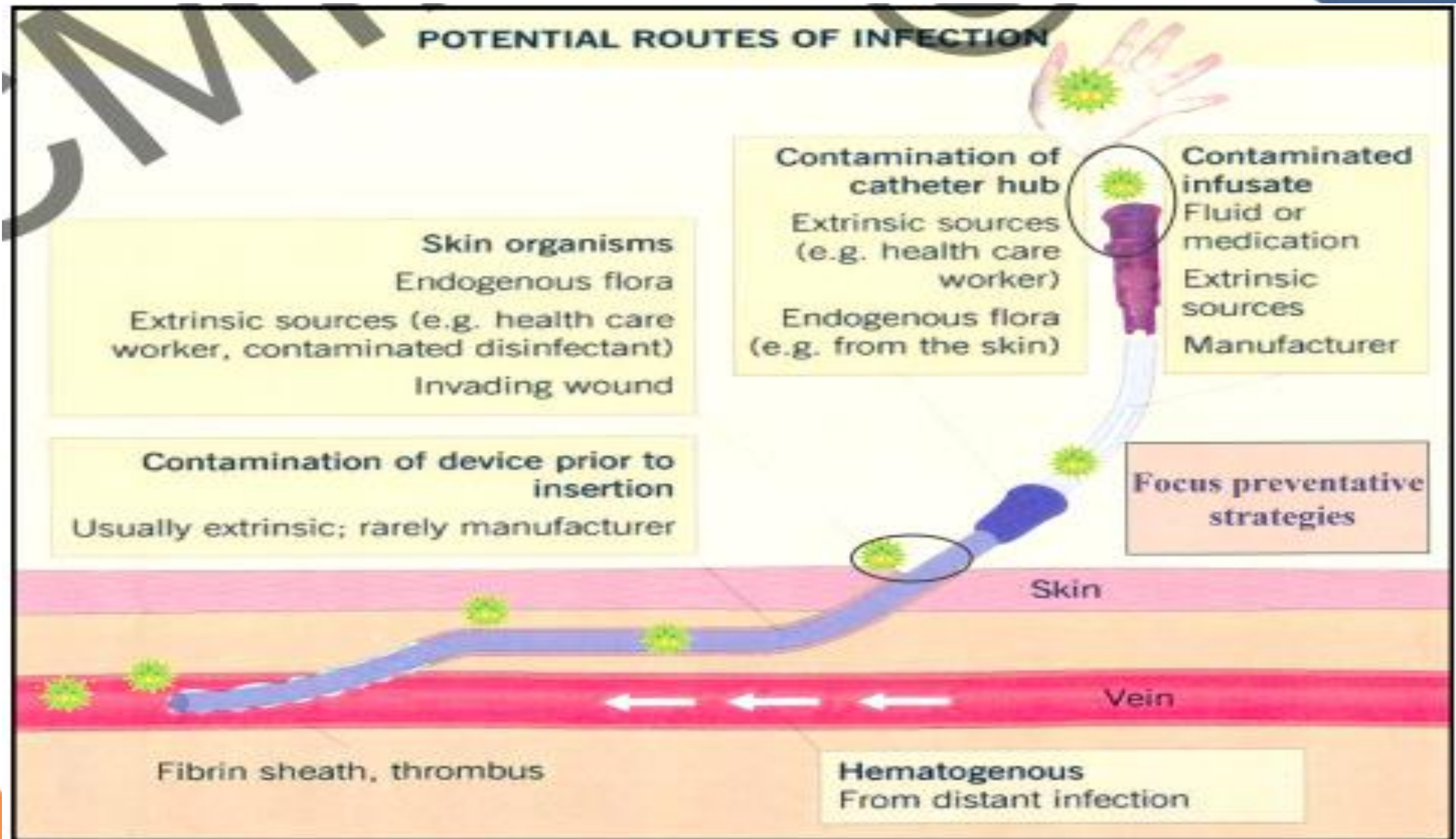
- Extra luminal: Pathogens migrate along external surface of catheter
 - More common in early period following insertion, **< 7** days
- Intraluminal: Hub contamination, migration along internal surface
 - More common **>7** days, intraluminal colonization

Less common mechanisms

- Hematogenous seeding from another source
- Contaminated infusate



POTENTIAL ROUTES OF INFECTION





CLABSI Diagnosis criteria

- Criteria 1 for Primary CLABSI
 - Patient has a central line that terminates at or close to the heart in one of the great vessels
 - Patient has one or more of the following signs/symptoms
 - Fever (>38 degrees C)
 - Chills
 - Hypotension



cont.

Criteria #2 for Laboratory Confirmed Primary CLABSI

- Patient has a central line that terminates at or close to the heart in one of the great vessels
- Patient has a recognized pathogen identified from one or more blood cultures
- Organism is not related to an infection at another site
- The same common commensal is identified from 2 or more blood cultures drawn on separate occasions



Strategies to Prevent CLABSI

- Two main strategies:
 - Judicious use and removal
 - Insertion/maintenance care bundles



Care Bundle

- A grouping of best practices that individually improve care, but when applied together result in substantially greater improvement
- Science behind the bundle elements is well established – the standard of care
- Bundle element compliance can be measured as “yes or no” (an all or none approach)



CLABSI Care Bundle Components.

- Hand hygiene
- Maximal barrier precautions
- Chlorhexidine skin antisepsis
- Optimal catheter site selection, with subclavian vein as the preferred site for non-tunnelled catheters in adults
- Daily review of line necessity with prompt removal of unnecessary lines



CLABSI Care Bundle Components (cont.)

Hand Hygiene should be a cornerstone of CLABSI prevention efforts:

- Ensure easy access to soap and water and alcohol-based hand gels
- Educate healthcare providers (HCPs) and patients
- Observe practices - particularly around high-risk procedures (before and after contact with a central line)
- Provide feedback – “Just in time” feedback if HCP fail to perform hand hygiene (for both insertion and line maintenance)



Cont.

Maximal barrier precautions during insertion

- Full body sterile drape
- Clinician and assistant wear cap, mask, sterile gown, gloves
- Persons within 6 feet wear cap and mask
- Skin antisepsis with
 - Chlorhexidine 2%
 - Isopropyl alcohol 70%



Cont.

Daily maintenance and review of central line necessity with prompt removal of unnecessary lines

- Assess dressing/site as per guidelines
- Change loose or wet dressings
- Determine if the patients meets criteria for line necessity for example:
 - Receipt of TPN
 - chemotherapy
 - extended use of antibiotics,
 - hemodialysis



Catheter Associated Urinary Tract Infection (CAUTI)

- **CAUTI Introduction**

- Account for most HAIs in the developed world hospitals
- Contributes to prolongation of hospital stay and extra costs
- Most CAUTIs follow:
 - Urinary catheterization
 - Sub optimal catheter care
- The risk of infections increases with length of urinary catheter use



Definition of Symptomatic CAUTI

- Symptoms of UTI (such as dysuria, urinary frequency, incontinence of recent onset, flank pain, fever etc.)
- Urinary catheter in place > 2 calendar days on the date of event (infection criteria met) or day before the event with day of device placement “Day 1”
- Patient had a positive urine culture of $> 10^5$ colony forming units(CFU)/ml with no more than 2 species of microorganisms



Risk Factors

- Acquiring a urinary tract infection depends on the following:
 - Method and duration of catheterization
 - Quality of catheter care
 - Host susceptibility
- Host factors increasing the risk of acquiring a CAUTI include :
 - Advanced age, debilitation
 - Postpartum state



Common CAUTI Pathogens

CAUTIs are caused by a variety of pathogens, including:

- *Escherichia coli*
- Klebsiella
- Proteus
- Enterococcus
- Pseudomonas
- Enterobacteriaceae
- Serratia
- Candida

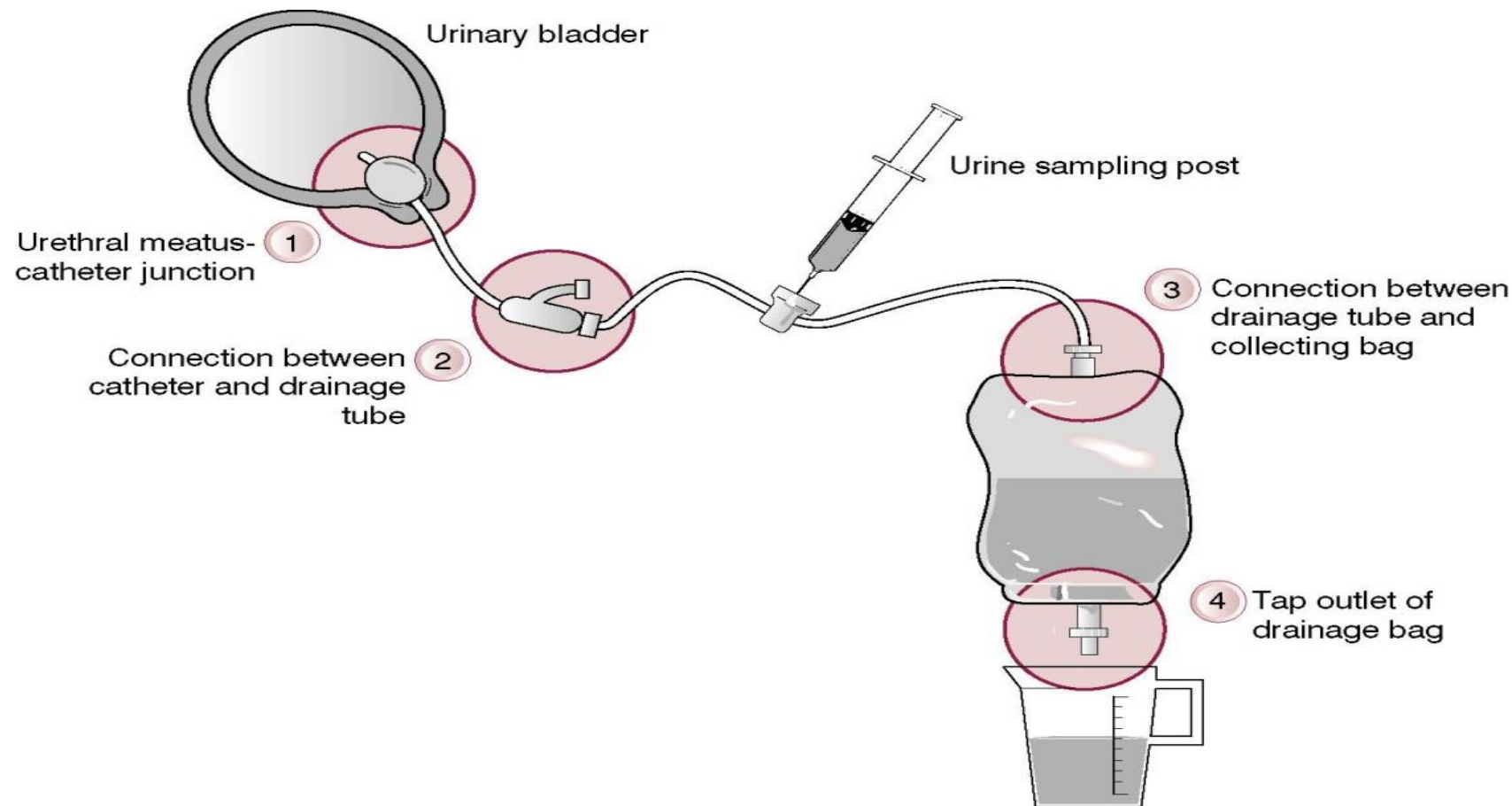


Pathogenesis of a CAUTI

- Normally urethral flora is flushed out
 - With catheterization, flushing mechanism is circumvented
- Flora can pass up through catheter or from drainage bag
- Hands of HCW may contaminate the system during insertion or management



Four Main Sites Through Which Bacteria May Reach the Bladder





Strategies to prevent Cauti.

1. Care bundles approach
 - Evidence-based interventions
 - When implemented together result in reduction in CAUTIs
2. HCWs skill



Care Bundles for Prevention of CAUTI

- Avoid unnecessary urinary catheters
- Insert using aseptic technique
- Maintain catheters based on recommended guidelines (daily care)
- Review catheter necessity daily and remove promptly if deemed appropriate



Avoid Unnecessary Catheters

Studies show that :

- 21% of catheters not indicated at insertion
- 41-58% inserted catheters found to be unnecessary

Catheters found to be:

- Uncomfortable for patients
- Decrease mobility, which may impair recovery and contribute to other complications (e.g. pressure ulcers, deep vein thrombosis)



Acceptable Indications for Urinary Catheter Placement

- Acute urinary retention or obstruction
- Perioperative use in selected surgeries
- Assist healing of perineal and sacral wounds in incontinent patients
- Output monitoring in critically ill patients (e.g., hourly output measurement)
- Required immobilization for trauma or surgery
- As an exception, at patient request to improve comfort (SHEA-IDSA) or for comfort during end-of-life care (CDC)



Examples of Inappropriate Catheter Use

- Incontinence
- Convenience
- Obtaining urine for culture or diagnostic test (when the patient can void)
- Prolonged post-operative duration (more than 1 or 2 days)



Insert Using Aseptic Technique

- Perform hand hygiene
- Insert catheters using aseptic technique and sterile equipment, specifically using:
 - Gloves, drape, sponges
 - Sterile or antiseptic solution for cleaning the urethral meatus
 - Single-use packet of sterile lubricant jelly for insertion
- Use the appropriate catheter size to minimize urethral trauma



Maintain Catheters Based on Recommended Guidelines

- Maintain a sterile, continuous closed drainage system
- Keep catheter properly secured to prevent movement and urethral traction
- Keep collection bag below the level of the bladder at all times
- Maintain unobstructed urine flow
- Empty collection bag regularly, using a separate collecting container for each patient
 - Draining spigot should not touch the collecting container or floor
- Maintain meatal care with routine hygiene



Additional Measures to Optimize CAUTI Risk Reduction

Condom catheters

- May be used for short-term drainage
- Requires frequent changes
- Remove if irritation or skin breakdown is observed
- Condom catheter use for 24 hours **continuously** should be avoided



Additional Measures to Optimize CAUTI Risk Reduction

Condom catheters

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Ventilator Associated Pneumonia (VAP)

- **Definition of VAP**
- Pneumonia where patient was on mechanical ventilation > 2 calendar days on date of event (infection criteria met) with day of ventilator placement “Day 1” and the ventilator was in place on day of event or the day before
 - Early onset= less than 4 days
 - Late onset= greater than 4 days
- Endotracheal intubation increases risk of developing pneumonia by 6 to 21 fold in mechanically ventilated patients



Introduction to VAP

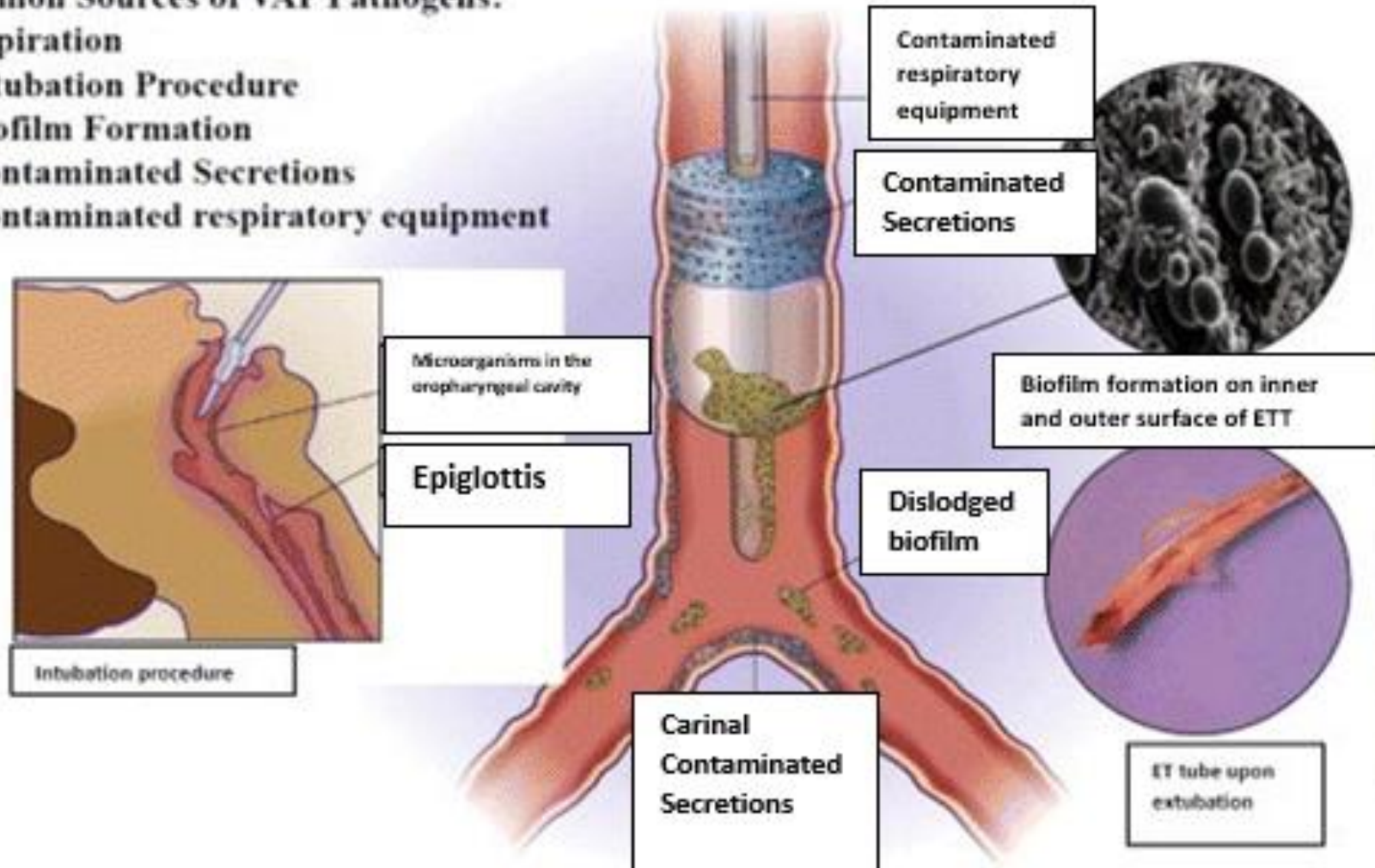
- 60% of all deaths attributable to HAIs infections
- Pneumonia rates are much higher in mechanically ventilated patients
 - Increased opportunity for aspiration and colonization



Pathogenesis of VAP

Common Sources of VAP Pathogens:

- ❑ Aspiration
- ❑ Intubation Procedure
- ❑ Biofilm Formation
- ❑ Contaminated Secretions
- ❑ Contaminated respiratory equipment





Introduction (cont.)

- VAP
 - Increases utilization of healthcare resources
 - Requires prolonged periods of mechanical ventilation
 - Extends hospitalizations
 - Leads to excess use of antimicrobial medications
 - Increases direct medical costs



Risk Factors for Ventilator-Associated Pneumonia (VAP)

Patient

- Age
- Burns
- Coma
- Lung disease
- Immunosuppression
- Malnutrition
- Blunt trauma

Devices

- Invasive ventilation
- Duration of invasive ventilation
- Re-intubation
- Medication
- Prior antibiotic treatment
- Sedation





VAP Care Bundles

- Hand hygiene
- Elevation of the head of the bed to 30°- 45°
- Daily sedative interruption and daily assessment of readiness to extubate (sedation vacation)
- *Peptic ulcer disease prophylaxis (PUD)*
- *Deep venous thrombosis (DVT) prophylaxis if not contraindicated*
- Oral care



VAP Care Bundles....Cont

Hand Hygiene

Proper hand hygiene is the most important measure in prevention healthcare acquired infections including VAP





Cont'

Elevation of Head of the Bed

- Recommended elevation is 30-45 degrees
- Sitting ventilated patients reduces esophageal reflux and pulmonary aspiration



Cont'

Sedation Vacation

- Sedative administration should be interrupted intermittently with patient observation
- Allow the patient to wake
 - If the patient is co-operative and able to understand commands leave the sedation off
 - Distressed or agitated patients require re-sedating
 - Administer boluses as appropriate to achieve safety
- Review the patient's analgesic requirements



Cont'

PUD Prophylaxis

- Include PUD prophylaxis as part of your intensive care unit (ICU) admission and ventilator order set
 - Reduce risks of stress ulcers (leading to GI bleeding)
 - Reduce risks for bacterial colonization of stomach to respiratory tract in case of aspiration
- Make application of PUD prophylaxis the default value on the ICU patient care order form
- Empower pharmacy to review orders for patients in the ICU to ensure that some form of peptic ulcer disease prophylaxis is in place at all times on ICU patients



Cont'

Deep Vein Thrombosis (DVT) Prophylaxis

- Include DVT prophylaxis as part of your ICU admission and ventilator order set
 - Reduce risk for venous thromboembolism
- Make application of DVT prophylaxis the default value on the ICU patient order form
- Include DVT prophylaxis as an item for discussion on daily multidisciplinary rounds
- Empower pharmacy to review orders for patients in the ICU to ensure that some form of DVT prophylaxis is in place at all times on ICU patients



Cont'

Oral Care

- Oral bacteria considered to be a primary cause of VAP
- Reports of the use of 0.2% Chlorhexidine gluconate gel 3 times a day improved patient outcomes
 - One study revealed that only 56% of hospitals had an oral care protocol
 - The study concluded that significant reductions in VAP could be achieved by implementing oral care protocols



Surgical Site Infections (SSIs)





Definition of Surgical Site Infections (SSI)

- Surgical site infections (SSIs) are defined as infections occurring up to 30 days after surgery (or up to one year after surgery in patients receiving implants) and affecting either the incision or deep tissue at the operation site.
- Types of SSIs:
 - Superficial incisional
 - Deep incisional
 - Organ or body space



Introduction

- The National Healthcare Safety Network (NHSN) reported 16,147 SSIs following 849,659 operative procedures (in-patient and out-patient combined) occur annually in the United States
 - Overall SSI rate of 1.9% between 2006-2008
- SSI is associated with a mortality rate of 3%
 - 75% of SSI-associated deaths are directly attributable to the SSIs

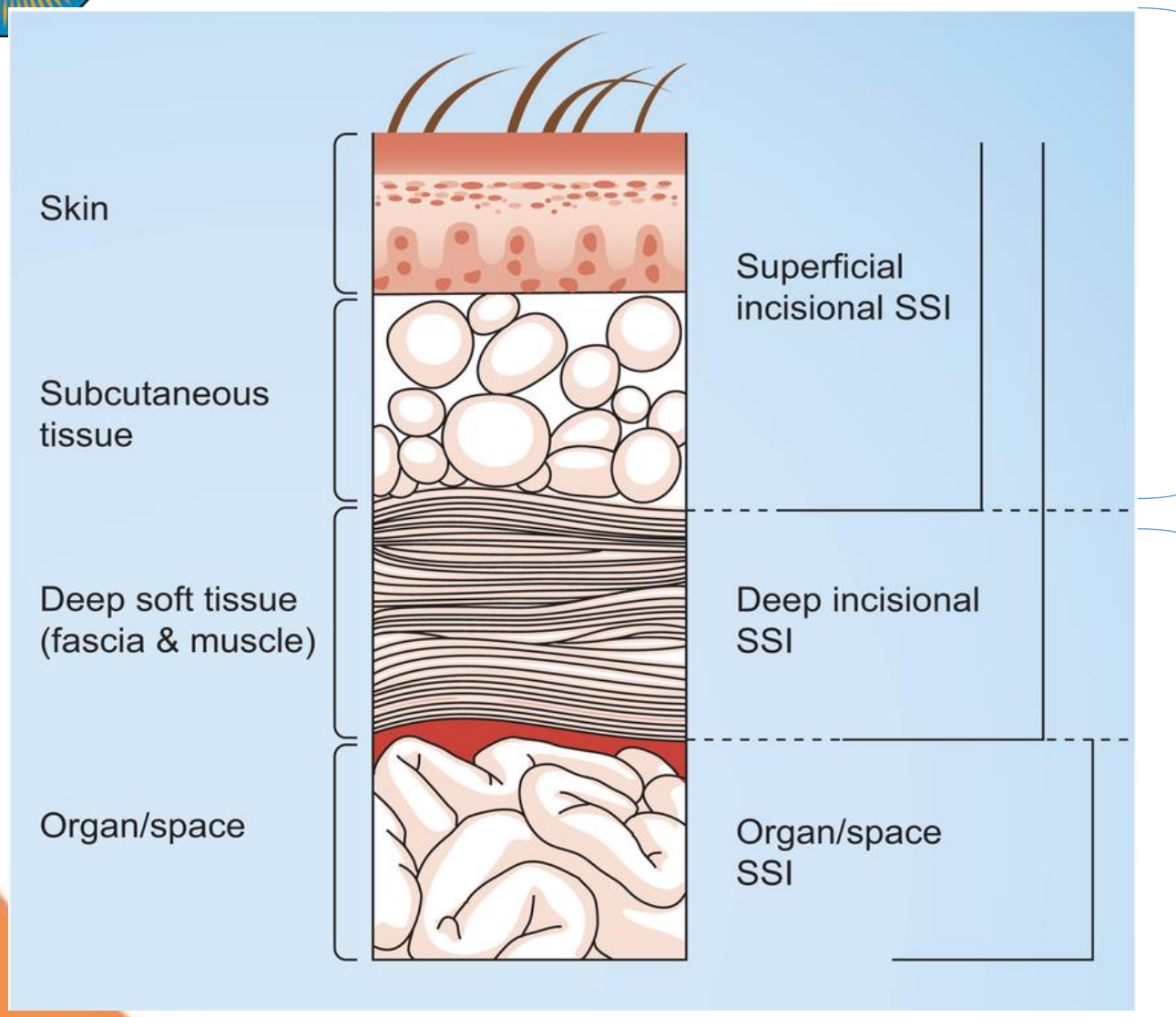


Cont'

- SSIs increase the length of stay in hospital by an average of 11days (2011 data)
- Patients who develop SSIs are:
 - 60% more likely to spend time in ICU
 - 5 times more likely to be readmitted



Classification of SSIs



Less severe, but
harder to reliably
diagnose

More severe,
but less
common



Surgical Wound Classification (SWC)

- Clean
- Clean-contaminated

} Most operations

- Contaminated
- Dirty-infected

} Small number of operations, mainly emergency cases

- SWC is normally the single most important risk factor for SSI



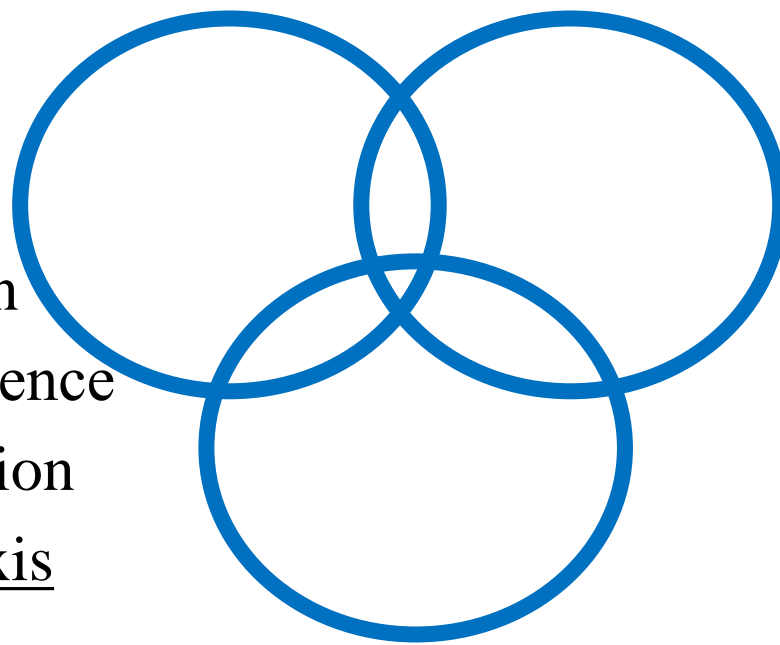
Risk Factors for SSIs

Operation factors:

- Surgical Wound Class
 - Procedure
 - Contamination
- Surgeon's experience
- Length of operation
- Use of prophylaxis
- Use of drains/prostheses

Patient-related factors:

- Age
- Hypothermia
- Smoking
- Diabetes
- Immunosuppression
- Nutritional status



Microbiological factors:

- Skin/GI/nasal carriage of micro-organisms
- Bacterial virulence factors + drug resistance
- Length of pre-operative admission



Strategies to Prevent SSI

Two main strategies

1. Care bundle
2. Surgeon skill



Components of SSI Care Bundle

The five components of SSI care bundle include:

1. Hand scrubbing
2. Appropriate use of prophylactic antibiotics
3. Appropriate hair removal
4. Controlled 6 am postoperative serum glucose
5. Perioperative and immediate postoperative normothermia especially in colorectal surgery patients



SSI Care Bundle

Surgical Hand Scrubbing

- Perform proper surgical hand scrubbing
- The purpose of surgical hand scrub is to:
 - Remove debris and transient microorganisms from the nails, hands, and forearms
 - Reduce the resident microbial count to a minimum, and
 - Inhibit rapid rebound growth of microorganisms.



Optimize Infection Risk Reduction

- Use appropriate antiseptic agent for skin prep
- Surgical team wears appropriate surgical attire
- Use proper aseptic and surgical technique during procedures
- Protect closed incision with sterile dressing for 24-48 hours postoperatively
- Maintain adequate/recommended ventilation processes in the operating rooms.



Additional Measures to Optimize Infection Risk Reduction

- Perform adequate cleaning and disinfection of environmental surfaces in the operating room (OR)
- Sterilize all surgical instruments according to guidelines
- Remove urinary catheter on postoperative day 1 or 2 with day of surgery being day zero
- Encourage patient tobacco cessation prior to surgery
- Conduct formal observations in the operating room looking for infection prevention related issues



Your Role and HAIs

- Follow the bundle components specific to your role in the patient's care
- Provide appropriate/indicated patient teaching regarding these bundle component and other recommended practices
- Document patient education related to the goal of HAIs prevention
- Remind peers of the importance of following the bundle components and other recommended practices if they are observed to be non-compliant



Summary of session

- Device-associated HAIs are the result of complex medical care, but can be prevented in most/all cases
- A prevention bundle is a set of evidence-based best practices that when implemented together result in better outcomes than when implemented individually
- Bundle components can easily be measured as completed or not completed by a **checklist** that demonstrates “all or none” compliance by a simple answer “Yes or No”
- Post compliance to the care bundles in a prominent place to encourage change and motivate staff



Cont'

- Surgical site infections are the most common HAI in surgical patients
- SSIs are the most common reason for readmission in the same population
- SSIs are very morbid and sometimes deadly, leading to poor outcomes and increased costs
- Evidence-based SSI prevention bundles should be used in every surgical patient to prevent infection
- The duration of catheterization is the most important risk factor for development of infection