Understanding the Chain of Infection

The Role of the SPD in Breaking the Chain to Prevent Surgical Site Infections (SSIs)?

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Chain of Infection

- List the components of the chain of infection
- List the three ways diseases may be transmitted
- Understand the role of the SPD professional in breaking the chain of infection
- List three keys ways to break the chain of infection
Infection Prevention & Control

It’s Everyone's Business!!

Everyone has a role in Infection Prevention & Control. We all have to work together.
Healthcare Associated Infections (HAIs)

- Significant cause of morbidity and mortality
- CDC 2002 estimates
  - 1.7 million infections annually are health care related
  - 99,000 people will die each year (1 of top 10 leading cause of deaths in the USA
  - approximately 8,200 were SSIs

Surgical Site Infections (SSIs)

- approximately 46.5 million surgical procedures each year\(^1\)
  - SSIs occur in 2%-5% of patients undergoing inpatient surgery in the USA\(^2\)
  - approximately 500,000 SSIs per year\(^2\)
  - increases length of stay by approx. 7-10 days\(^2\)
  - patients have 2-11 times higher risk of death\(^2\)
  - 77% of death directly attributable to SSIs\(^2\)
  - SSI costs range from $3,000 - $29,000\(^2\)
  - $10 billion in annual healthcare expenditures\(^2\)

Surgical Site Infections (SSIs)

- **Wound Classification**
  - Class I/Clean
  - Class II/Clean Contaminated
  - Class III/Contaminated
  - Class IV/Dirty

- **SSI Classification**
  - Superficial incisional (skin/subcutaneous tissue)
  - Deep incisional (fascia and muscle)
  - Organ-space (e.g. mediastinitis, osteomyelitis, meningitis)

Surgical Site Infections

- **Surveillance**
  - Superficial incisional SSI (primary/secondary)
  - Deep incisional SSI
  - Organ/space SSI

- **SSI is health care-associated if:**
  - 30 days if no implant
  - One year in the presence of a implantable devices

- **Implant** – A nonhuman-derived object, material, or tissue (eg, prosthetic heart valve, nonhuman vascular graft, mechanical heart, or hip prosthesis) that is permanently placed in a patient during an operative procedure and is not routinely manipulated for diagnostic or therapeutic purposes.
THE CHAIN OF INFECTION

- Infectious Agent
- Susceptible host
- Portal of entry
- Mode of transmission
- Mode of escape
- Reservoir
The Infectious Agent

- First link in the chain of infection
  - viruses
  - bacteria
  - fungi
  - parasite
  - prion

- Pathogenicity - ability of microorganism to cause disease
  - Virulence - severity of the disease
  - Invasiveness - ability of organism to invade tissues
  - Infective Dose - amount of microorganism necessary to cause infection
Microbial contamination of surgical site

- Contamination with $>10^5$ organisms/gram increases risk of infection
- Dose of organism is less if foreign material/body in place

- Most are from patient’s own flora (endogenous - skin, mucous membrane or hollow viscera)
- Seeding of the operative site from a pre-existing infection
- Contaminated equipment, instruments, etc. in the sterile field (exogenous)

Reservoir

- Agent lives, grows, multiplies and persists
- Source - where infectious agent passes to the susceptible host
  - animate
    - hands of colonized or infected healthcare worker
    - colonized or infected patients
  - inanimate objects (fomites)
    - contaminated equipment and medical/surgical instruments
    - environmental surfaces
Portal of Exit

- Major portal of exit from the reservoir
  - respiratory tract
  - gastrointestinal tract
  - skin and wounds
  - body fluids - secretions and excretions
  - droplets - coughing, sneezing, etc.
Transmission of Infection

- **Contact**
  - Direct transmission
    - Person to person
  - Indirect transmission
    - Person to person by an inanimate object (fomites)

- **Droplet transmission**
  - Large droplet
  - Spread by coughing, sneezing, talking, singing, etc.

- **Airborne**
  - Spread through the air
  - Droplet nuclei

- **Vehicle**
  - Spread through a contaminated common source such as food, water, medication, hands etc.

- **Vectorborne**
  - Insects (mosquitoes), fleas, mites, lice and ticks
Portal of Entry

- Infectious agent enters the susceptible host
- May be the same as the portal of exit
  - mucous membrane (nose, eyes, mouth)
  - skin (non-intact)
  - respiratory tract - bronchoscope
  - genitourinary tract (cystoscope introduced into the urinary tract)
  - gastrointestinal tract (endoscope into the GI tract)
Susceptible Host (Patient)

- Infection is dependent on host resistance
- Weakened immune system makes susceptibility to infections a greater risk
  - very old and very young
  - immunocompromised/immunosuppressed
    - cancer, AIDS, transplant patients
  - poor nutritional status
  - smoking
  - diabetes
  - obesity
  - other underlying comorbidities
Breaking the Chain

The Role of the SPD
The organization reduces the risk of infections associated with medical equipment, devices and supplies.

- Applicable to Ambulatory Care, Critical Access Hospitals, Hospitals, and Office-Based Surgery
- Effective as of October 2009
  - EP1 and 2 revised to clarify requirements to reduce the risks associated with medical equipment, devices and supplies
  - Changing medical instrumentation and technology and emerging new or resistant pathogens
The Joint Commission will survey for:

- Orientation, training and competency of the health care worker (HCW) who process medical equipment, devices and supplies
- Levels of staffing and supervision of the HCW who process medical equipment, devices and supplies
- Standardization of the process regardless of whether it is centralized or decentralized
- Ongoing quality monitoring
- Observation against the manufacturers guidelines and the organization procedures.
The organization implements infection prevention and control activities when doing the following:

EP 1
- Cleaning and performing low-level disinfection of medical equipment, devices, and supplies.

EP 2
- Performing intermediate and high-level disinfection and sterilization of medical equipment, devices, and supplies.
Breaking the Chain

Prevention of healthcare-associated infection is directed at the various links in the chain.

- eliminate or contain the reservoirs of agents
- interrupt the transmission of infection
- protect the patient (host) against infection and diseases
Breaking the Chain

“The importance of this [CSD/SPD] role in the prevention of nosocomial [HAIs] is clear: reusable medical devices improperly handled, disinfected, or sterilized provide a source of contamination and increase the risk of transmission of infection to both patients and the staff involved in reprocessing procedures.”

CSD/SPD Role – Breaking the Chain of Infection

Direct healthcare providers (such as physicians, nurses,...) and ancillary personnel (such as housekeeping and equipment-processing personnel) are responsible for ensuring the appropriate infection prevention and control practices are used at all times (including hand hygiene; strict adherence to aseptic technique; cleaning and disinfection of equipment and the environment; cleaning, disinfection, and sterilization of medical supplies and instruments and appropriate surgical prophylaxis protocols).
Health-Care Associated Infections – Adverse Outcomes

- **1961** – 3 cases of *Clostridium perfringens* SSI related to inadequate cleaning of instruments and sterilizer failure

- **1981** - 6 cases of *Pseudomonas aeruginosa* meningitis or intraabdominal abscess traced to sterilizer failure
  - Epidemiologic link to possible flash sterilization processing of implantable neurosurgical devices

- **1991** - Improperly sterilized surgical equipment linked to an outbreak of postsurgical nasal cellulitis with *Mycobacterium chelonae*

- **2002** - Improper packaging of surgical linens/drapes prior to autoclaving associated with an outbreak of polymicrobial ventriculitis in a surgical ICU

Sehulster and Schultz. Central Sterile Supply. In Hospital Epidemiology and Infection Control 3rd edition.
Health-Care Associated Infections – Disease Transmission

- Endoscopy related HAIs through July 1992\(^{(1)}\)
  - 281 infections transmitted by gastrointestinal endoscopy
  - 96 infections transmitted by bronchoscopy

- 3-state VA outbreak of bloodborne pathogens due to improperly reprocessed endoscopes \(^{(2)}\)
  - As of July 6, 2009 (all sites of the outbreak)
  - HBV = 12
  - HCV = 36
  - HIV = 8

2. US Department of Veterans Affairs
According to the CDC, Surgical Site Infections are the most common adverse event for surgical patients.

CDC’s National Nosocomial Infections Surveillance (NNIS) System (now referred to as National Healthcare Safety Network – NHSN)
System Design – How is your system designed?

Every system is perfectly designed to get results it consistently achieves.

*Donald M. Berwick*, MD, MPP, FRCP, President and CEO, Institute for Healthcare Improvement (IHI)

Is your system/process designed to consistently break the chain of infection? Prevent infections?
“The sterilization risk analysis should be part of the overall infection prevention and control risk analysis in accordance with accreditation agency requirements.”

- Risk assessment (FMEA)
- Risk management (ANSI/AAMI ST79, Root cause analysis)
- Risk communication (Recall procedure)

“It should be performed annually and should be reevaluated whenever significant changes occur.”

Root Cause Analysis and Failure Modes Effect Analysis

- Defect with Central Sterile is not doing the right thing, every day, every time to protect patient safety.
- Treat every issue or incident that could possibly impact patient safety as a defect.
- Root cause analysis (RCA) and failure modes effects analysis (FMEA) should be a standard part of practice.
- Requires an integrated, multi-disciplinary team.
Failure Modes and Effects Analysis (FMEA) - Infection Prevention

- A systematic, proactive method for evaluating a process to identify where and how it might fail - ANTICIPATION

- Assess the relative impact of different failures, in order to identify the parts of the process that are most in need of change.

- Steps in the process
- Failure modes (What could go wrong?)
- Failure causes (Why would the failure happen?)
- Failure effects (What would be the consequences of each failure?)

http://www.ihi.org
Root Cause Analysis

- Infection Control – Reactive/Retrospective Process (Response/Recovery)
- Focus on performance improvement
- Systematic process – identify deficiencies or root cause for the error or adverse event
- Includes analysis of pre- and post-identification of infection
- Cause and effect fishbone diagram
- Answers the “Why” questions
- Based on analysis, identify improvements and implement to avoid recurrence
What are the parts of the process?

- Cleaning and Decontamination
- Preparation and Packaging
- Sterilization
- Sterile Storage and Distribution
- Record Keeping
- Recall Procedures
Is Your System/Process Designed for Infection Prevention?

EVERY STEP IN THE PROCESS HAS POTENTIAL FOR FAILURE!

Based on James Reason’s Swiss Cheese Model

http://consumerist.com/368325/california-hospital-takes-botched-operations-seriously from Google Images
... Or Is Your System/Process Designed for Infection Control?

EVERY STEP IN THE PROCESS HAS POTENTIAL FOR FAILURE!

Based on James Reason’s Swiss Cheese Model

Image from Gordon, Steven New Surgical Techniques and Surgical Site Infections. EID 2001; 7 (2):217-219

It is a flawed system that will allow a problem at the beginning to progress all the way through to adversely affect patient safety.
“Senior management is accountable for ensuring that healthcare personnel, including licensed and non-licensed personnel are competent to perform their job responsibilities”.

Strategies to Prevent Surgical Site Infections in Acute Care Hospitals. SHEA/IDSA Practice Recommendations, 2008
CSD/SPD Role – Breaking the Chain of Infection

Leadership must ensure:

- Accountability of all staff responsible for the process
- There is adequate resources to carry out the functions of the CSD/SPD including the hiring of certified staff committed to patient safety.
- Recommended practices, evidenced-based guidelines and regulations are incorporated into policies and procedures and are followed.
- Appropriate training and educational programs to prevent SSIs are developed and provided to personnel, patients, and families.
Design the sterilization process to prevent error? (SCARR)

- **S**tandardize the process
- **C**hecklists - outline all the steps
- **A**utomate the process
- **R**educe the number of steps and handoffs
- **R**edundancy (double checks)
Standard Precautions (Universal Precautions)

- Assume all patients to be potentially infectious with bloodborne pathogens
- Assume all blood/body fluids potentially infectious
- Use personal protective equipment based on the task they are performing and risk of exposure - not the diagnosis of the patient - gowns, gloves, shoe covers, mask and eye protection
If the chain is unbroken...

BEFORE
Complements of LifeBridge Health Laboratories. Handprints courtesy of Emily.

AFTER
Hand hygiene is the single most effective and inexpensive procedure for preventing the spread of infection!

Handwashing – 15-20 seconds

Hand sanitizer – rub until dry
Hand hygiene is the single most effective and inexpensive procedure for preventing the spread of infection!

Purpose
- Remove soil, organic material and visiting bacteria, viruses, and fungi from the skin

Handrubs
- Apply to palm of one hand, rub hands together covering all surfaces until dry
- Volume: based on the manufacturer

Handwashing
- Wet hands with water, apply soap, rub hands together for at least 15 seconds
- Rinse and dry with disposable towel
- Use towel to turn off faucet

Guideline for Hand Hygiene in Health-care Settings. MMWR 2002; vol. 51, no. RR-16.
Effective hand hygiene means washing all areas of the hands!
Fingernails and Artificial Nails

- Natural nail tips should be kept to ¼ inch or less in length (CDC II; WHO II)
- Artificial nails or extenders are not be worn when having direct contact with high-risk patients (e.g., ICU, OR) (CDC 1A; WHO 1A)
- Especially important in Prep and Pack

Personal Protective Equipment (PPE) – Portal of Exit/Entry

- Liquid-resistant covering with sleeves
- Heavy-duty latex free or plastic gloves
- Surgical face mask (impervious to fluid and high filtration)
- Safety glasses that wrap around the eye or face shield
- Disposable hair covering
- Proper footwear

Breaking the Chain of Infection - The Reservoir

- CSD/SPD Design
  - Adequate space to carry out reprocessing to allow physical separation of clean and dirty
  - Proper humidity, ventilation, and temperature control to control bioburden and environmental contamination
  - Appropriate storage of sterile goods
  - Maintenance of a safe workplace

Breaking the Chain of Infection - Decontamination

- Cleaning (manual or automated) and decontamination
- Important first step in prevention of healthcare-associated infections (HAIs)
- Reduces bioburden making instruments safe for handling and further processing
- Eliminates the reservoir
- Eliminating the infectious agent
- Allows for effective sterilization
- Prevents transmission
- Protecting the susceptible host

Follow Manufacturer’s Written Instructions
For example ... Toxic anterior segment syndrome (TASS)

- TASS is an acute inflammation of the anterior chamber, or segment, of the eye following cataract surgery.
  - detergents
  - heat stable endotoxin from overgrowth of Gram negative bacilli in water baths of ultrasonic cleaners
  - degradation of brass-containing surgical instruments in plasma gas sterilization
  - Impurities of autoclave steam
- Break the Chain by improving the steps of the cleaning process and sterilization

Recommended Practices for Cleaning and Sterilizing Intraocular Surgical Instruments. ASCRS and ASORN
Breaking the Chain of Infection - Packaging

- Inspection and Packaging
  - items inspected for cleanliness
  - contain and maintains sterility of sterilized items
  - impervious to bacteria and other microorganisms
  - compatible with the sterilization process
  - rigid sterilization container systems should be 25 pounds or less
  - allow for event related dating
  - Proper loading and unloading of the sterilizer to prevent contamination.

- Eliminates
  - the reservoir
  - the infectious agent/source
  - transmission

- protects the susceptible patient/host

Breaking the Chain of Infection - Sterilization

- Sterilize instruments according to published guidelines (CDC IB)\(^1\)

- Flash sterilization only for items for immediate use in an emergency (CDC IB)\(^1\)

Monitoring
- Physical monitors
  - Gauges, charts, printouts, etc.
  - Bowie Dick-type Tests
- Chemical indicators (CI)
- Biological indicators (BI)
- Review at the end of each load
- Release load with the BI results
- Monitor every load with an implant with a PCD containing a BI along with a Class 5 CI
- Proper documentation of the process

Eliminates
- infectious agent
- reservoir
- transmission

Protects the susceptible patient

Breaking the Chain of Infection - Sterile Storage

- Separate area with restricted access
- Proper ventilation to protect against dust, moisture and extremes of temperature and humidity
- Free of insects and vermin
- Sterile items should be stored away from outside walls, off the floor and away from the ceiling
- Stored to prevent physical damage
- Sterile packages should be minimally handled to reduce the risk of contamination of the contents
- Sterile packages transported to the point of use should be protected to prevent contamination

Product Testing

- Verify and maintain efficacy after any changes are made in sterilization process

- Changes include:
  - Packaging materials
  - Containers
  - Load contents
  - Packaging dimensions, weight, and load configuration
  - New product to sterilize

CS Professional’s Role – Prevention of HAIs - Summary

- Follow Standard (Universal) Precautions
- Know how diseases are transmitted
  - Airborne, contact, droplet
- Protect portal of entry/exit with the wearing of appropriate PPE and adherence to proper hand hygiene
- Hand hygiene – most important method for preventing the spread of infection
- Attention to work flow
- Area is restricted to authorized persons only
Summary

- Quality process does not automatically translate into patient safety
- Design the process to anticipate and address the causes of errors to ensure breaking the chain of infection and infection prevention
- Conduct regular risk analysis of the various processes and identify potential problems using tools such as FMEA
- Infection Control (response and recovery is reactive and requires a RCA)
Focus on your role in breaking the chain of infection – Source/Reservoir/Mode of Transmission

Key Points - Prevent cross-contamination

- Strict asepsis
- Optimal cleaning and disinfection of the environment
- Cleaning, disinfection, and sterilization of medical supplies, equipment and instruments
- Avoid working when sick - shedding of organisms (Culture Change)
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THANKS
References

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