Cleaning, Disinfection and Sterilization

Basics of Infection Prevention
2-Day Mini-Course
October 2016
Objectives

- Describe basic principles of cleaning, disinfection, sterilization
- Identify when to use cleaning, disinfection, or sterilization
- Describe how to monitor cleaning, disinfection and sterilization processes
Terminology

• Cleaning
  – general removal of debris (dirt, food, feces, blood, saliva and other body secretions)
  – reduces amount of organic matter that contributes to proliferation of bacteria and viruses

• Disinfection
  – removes most organisms present on surfaces that can cause infection or disease

• Sterilization
  – the killing or removal of all organisms
Cleaning, Disinfection and Sterilization in Healthcare Settings

• Practice standards are based on Spaulding’s Classification system
• Healthcare devices and equipment designated as
  • Critical
  • Semi-critical
  • Non-critical
• Categories define level of reprocessing required
Critical Items

- Require sterilization
- Includes items that enter sterile tissue or the vascular system
- Examples include surgical instruments and accessories, biopsy forceps, cardiac and urinary catheters, implants, needles
Semi-Critical Items

- Require minimum high level disinfection (or sterilization)
- Includes items in contact with non-intact skin or mucous membranes
- Examples include respiratory therapy equipment, anesthesia equipment, flexible and laryngoscopes, bronchoscopes, GI endoscopes, cystoscopes, vaginal ultrasonic probes
- Cleaning process must precede high-level disinfection
Non-Critical Items

- Require intermediate-level or low-level disinfection
- Includes items in contact only with **intact skin**
- Examples include BP cuffs, stethoscopes, durable mobile patient equipment
Environmental Cleaning

- Patient environment can facilitate transmission of bacteria and viruses
  - By direct contact
  - On hands of healthcare personnel
- Contaminated surfaces increase potential for transmission of bacteria and viruses between patients
- Items categorized as non-critical (intermediate or low disinfection) or require cleaning only

X represents VRE culture positive sites
Policy Considerations

- Include in policy all surfaces and equipment that can reasonably be expected to be contaminated by bacteria (high touch surfaces)
- Define responsibility and frequency for cleaning and disinfecting patient care equipment and surfaces
- Monitor compliance with policy
- Staff should be able to answer question “How do you know whether this item has been cleaned and/or disinfected?”
- Cleaned/disinfected items should be labeled (date/time)
High Touch Surfaces in Patient Rooms

- Considered non-critical
- Must be cleaned *then* disinfected on a regular basis
- Examples include:
  - Bedrails
  - Call bell
  - Telephones
  - TV remote
  - IV pump
  - IV poles
  - Toilet, commode chair
  - Overbed table
  - Light switches
  - Doorknobs
  - Respiratory and other bedside equipment
  - Computer keyboard
  - Chairs
Increased acquisition risk from prior room occupant 6 studies as of January 2011

- Huang: MRSA, VRE
- Hardy: MRSA
- Dress: VRE
- Shaugnessy: C. difficile
- Datta: MRSA
- Nseir: Pseudomonas
- Nseir: Acinetobacter

Average = 120%

Increased Risk of Acquisition (%)
Items Requiring *only* Cleaning

- Floors, walls, and windows
- Chairs and other furniture used by individuals who are clothed
- Private offices and other non-public, non-patient care areas
- Bed curtains should be changed when soiled and w/ terminal cleaning

Clarify in policy what needs to be cleaned and not necessarily disinfected
Use Microfiber for Cleaning

- Densely constructed synthetic strands ~1/16th the diameter of a human hair
- Attracts dust, cleans ~50% better than comparable cotton
- Easier to use, lighter, designed for repeat usage

HICPAC Disinfection & Sterilization Guideline 2008, Rutala
Monitor Environmental Cleaning Processes

- **Bioluminescence (outcome measure)**
  - Monitors for light emissions produced if organism present
  - Results difficult to interpret because it is unknown whether organism remains viable and thus transmissible
  - Expensive

- **Fluorescence (process measure)**
  - Monitors for chemical markers that fluoresce with ultraviolet (black) light if not removed during cleaning

- **Culturing**
  - Should *not* be done except during some outbreak investigations

- **Visual inspection**
  - Make routine rounds and provide feedback to frontline staff
Linens

- All linen handled as if contaminated with blood or body fluids (Standard Precautions)
  - Bag linen at point of use
  - Wear PPE when sorting and agitate minimally
- Laundry equipment must be maintained to prevent microbial contamination*
- New laundry technologies allow linen washing without requirements for hot water and chlorine
  - Hot water - 160°F x 25 min
  - Cold water - 71-77°F with 125 ppm chlorine bleach rinse or equivalent detergent
- Detergents not required to have stated anti-microbial claims*

*Manufacturer’s instructions for use must be followed
You CANNOT achieve disinfection or sterilization without pre-cleaning

- As organic material dilutes disinfectants, bioburden must be reduced for processes to be effective

Clean all medical instruments and devices as a first step

- Remove visible soil
- May need to disconnect or separate instrument parts
- Avoid organic material drying on equipment by rinsing or soaking in an enzymatic solution
Personal Protection

When cleaning soiled medical instruments, wear

- Long sleeved impervious gown
- Eyewear
- Mask or mask with face shield
- Gloves
- Cap
- Chemical goggles (when mixing or changing solution)
Disinfection

- Eliminates or kills most bacteria, many virus types, some fungi (not prions)
- Cannot be accomplished without first cleaning
- Time-dependent process
- Levels of disinfection - high, intermediate, or low
- Hospitals must use EPA-approved product for desired level of disinfection
  - Has minimally a tuberculocidal label claim
Disinfection - continued

• Follow manufacturer’s recommendations to achieve disinfection and to avoid medical device damage method
  – Use correct dilution – more is **not** better!
  – Use correct contact time
  – Use correct temperature

• Understand employee and environmental safety issues
  – Do not exceed exposure limits
  – Know permissible exposure levels
  – Assess compatibility with gloves, basins, other products
EPA Registration of Disinfectants

- Labeled as high level vs. intermediate vs. low level
- May include degrees of approval
  - Limited approval, e.g. kills Hepatitis B and HIV but not approved for spores
- Select disinfectant based on what you are trying to accomplish
  - Environmental vs. medical device disinfection
- Search EPA website by product name
  
  www.epa.gov/oppad001/chemregindex.htm
High-level Disinfection

- EPA approved products include gluteraldehyde, ortho-phthaldehyde (OPA), peracetic acid & hydrogen peroxide.
- Ensure achievement of temperature requirements.
- Test product prior to each use.
  - Can get diluted with frequent use.
  - Follow facility policy.
  - Test strips expire; monitor dates.
- Change product as indicated by test and as manufacturer requires.
- Maintain log records.
- Ensure competency of staff.
Endoscopes/Bronchoscopes

- United States
  - An estimated 14.4 million gastrointestinal endoscopic procedures are performed annually in the US, including 500,000 ERCPs.\(^1\)
  - Since 2013, there have been 69 infections with CRE related to duodenoscopes; 13 deaths may have been partially attributable to the infection that developed after exposure to the scope.\(^2\) Professional organization guidelines require:
    - Minimum high-level disinfection
    - Ensure competency of personnel performing process
  - Outbreaks associated with failure to comply with guidelines for disinfection/sterilization

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\(^1\) ASGE, FDA, March 5, 2015
\(^2\) CDC 2014, 2015 Communications
Endoscopy/Bronchoscopy-Associated Infections

Endoscopy

• More healthcare-associated outbreaks are associated with endoscopes than any other medical device
• Scopes acquire high levels of contamination with use (bioburden) due to high bacteria levels in areas explored

Bronchoscopy

• Evidence of transmission of pathogens from inadequately processed bronchoscopes including
  • Mycobacteria – resistant to many disinfectants
  • Pseudomonas aeruginosa – problematic MDRO

http://www.cdc.gov/hicpac/Disinfection_Sterilization/toc.html
The 5 Steps of Endoscope Re-Processing

Key concept: Perform steps in order. Do not skip steps!

1. Clean
   - Remove debris/tissue which can impede disinfection process, flush all lumens (water & enzymatic cleaner)
2. High Level Disinfection
   - Perfuse through ALL channels with disinfectant
3. Rinse all channels
   - Sterile or filtered water, follow with alcohol rinse
4. Dry: force air through all channels
5. Store
   - Hang vertically in a closed cabinet to promote drying and avoid recontamination
Factors Leading to Outbreaks from Endoscope/Bronchoscope Contamination

- Contaminated water supply
- Contaminated brushes for cleaning scope lumens
- Improper manual cleaning prior to disinfection
- Biofilm inside automatic washer
- Improper use of automatic washer
- Contaminated or expired disinfection reagent
- Inability or neglect to clean the suction
- Mechanical or design issues related endoscope/bronchoscope

Elevator shaft on a duodenoscope
CDC Interim Guidelines for Reprocessing Duodenoscopes Used for Retrograde Cholangiopancreatography (ERCP) Procedures

- Inspect and manually clean the elevator mechanism
- Perform in open/raised and closed/lowered positions
- Ensure that all channels of the scope and elevator mechanism are thoroughly dried before storage
- Use of ERCP scope culturing to ensure effectiveness of reprocessing
  - See CDC suggested algorithm
  - Take remedial action if a scope is culture-positive for high concern organisms or if unacceptable colony counts of low-concern organisms

Environmental Disinfectants

- Phenolics
  - “Gold Standard” in healthcare
  - Toxicity concerns prohibit use in nurseries, NICU
  - Does not kill spores

- Quaternary ammonium compounds
  - Approved for specific pathogens (read the label!)
  - Affected by water hardness
  - Affected by bioburden
  - PPE use required (estrogen-like effect with contact, use gloves)


Correct dilution and wet contact time is critical to effectiveness.
Environmental Disinfectants - continued

• Iodophors
  • Can be used in food preparation areas
  • Inactivated by organic materials, e.g. blood
  • Can stain surfaces

• Chlorine (bleach)
  • Inactivated by organic materials, e.g. blood
  • Kills spores, e.g. *C. difficile*
  • Corrosive
  • Highly toxic (deadly) if combined with ammonia
Environmental Disinfectants - continued

• Disinfectant spray-fog techniques for antimicrobial control in hospital rooms
  • Unsatisfactory method of decontaminating air and surfaces
  • Not recommended for general infection control in routine patient-care areas

• Ultraviolet Radiation
  • Dependent on strength and duration of exposure to light, ‘line of sight’, how well microorganism can withstand UV
  • Limited to destruction of airborne organisms, inactivation of microorganisms on surfaces, and water purification
Demonstrating the susceptibility of organisms to specific disinfectant types

MORE RESISTANT

Bacterial Spores (Bacillus, Clostridium - including C. difficile)

Mycobacteria (M. tuberculosis, M. terrae, M. chelonei)

Small, non-enveloped viruses (Poliomyelitis, parvovirus, papilloma virus, norovirus)

Fungi (Aspergillus, Penicillium)

Gram-negative bacteria (Pseudomonas, Providencia, Escherichia, Klebsiella - including KPC, Acinetobacter)

Large, non-enveloped viruses (Adenoviruses, rotaviruses)

Gram-positive bacteria (Staphylococcus - including MRSA, Streptococcus, Enterococcus - including VRE)

Enveloped viruses (Human immunodeficiency virus, Hepatitis B virus, Hepatitis C virus, Influenza A virus)

MOST SUSCEPTIBLE

Quaternary Ammonium Compounds, Organic Acids

Phenol, Quat and Solvent (i.e. Alcohol), Iodophors, Alcohols

Aldehydes, Hypochlorites (higher ppm), Peroxides, Chlorine dioxide, Ethylene oxide

Graphic used with permission from Ecolab - 2015
Sterilization

Achieved by

- Steam
- Dry Heat
- Ethylene Oxide
- Peracetic Acid
- Plasma Gas (vaporized hydrogen peroxide)
- Glutaraldehyde (using higher concentrations and exposure times than for high-level disinfection)
Steam Sterilization - Autoclave

• Achieves rapid heating and penetration
  – Short exposure times (<20 minutes) but temperature must be maintained throughout
  – No toxicity to workers
  – Inexpensive
  – Can damage delicate instruments

• Items to be sterilized must be
  – Clean and free of protein (blood) or other organic material
  – Packaged so that the steam can penetrate

• Autoclave must be loaded correctly
Rapid Cycle or Flash Sterilization

• “Unwrapped” steam sterilization
• Should only be used when absolutely necessary
  – Do not flash whole trays of instruments
  – Items must be used immediately
  – Avoid flash sterilization by keeping adequate supply of frequently dropped items
• Maintain records or “flash logs”
  – Include all implants
  – Requires same monitoring processes as routine steam sterilization in hospital
  – Use to support need for additional instruments
Monitoring Sterilization

- **Mechanical Indicators**
  - Gauges, displays, printouts
  - Indicates if device working properly
  - Not indicator of sterility

- **Chemical Indicators**
  - Change color with timed exposure to heat, steam
  - Not indicator of sterility
  - Used to show items have gone through sterilization process

- **Biological Indicators**
  - Indicator of sterility
  - Demonstrates bacterial spores on test strips or in vials/containers have all been killed
  - Results can be available in 1 hour
Storage of Sterile Items

- Protect sterility until ready to use
  - Store to protect packages from dust, moisture, falling on floor
  - Transport only covered, dry packages
  - Handle to protect package integrity
    - Refrain from crushing packages or ‘rubber-banding’ them for storage
    - Wrap sharp points in gauze

- Rotate sterile items first in, first out

- Store and label for effective recall system

- Expiration date vs. Event-related sterilization
  - Needs a program flex from L&C
IP Role in Cleaning, Disinfection, and Sterilization

• Know the processes; update the policies
• Know directors of environmental services, sterile processing, operating room, endoscope services
• Know where all sterilization and disinfection is being done
  ▫ May include
    • Radiology
    • GI dept
    • Cardiac cath lab
    • Wound care center
  • Outpatient clinics
  • Emergency room
  • Same day procedures
  • Ambulatory surgery
• Ensure staff know and follow contact times for products
  ▫ Per manufacturer guidelines; on labels
Questions?
Thank you