

[https://upload.wikimedia.org/wikipedia/commons/a/a0/Laboratory\\_autoclave\\_\(cropped\).jpg](https://upload.wikimedia.org/wikipedia/commons/a/a0/Laboratory_autoclave_(cropped).jpg)



No endorsement of any products



**Infection Control**  
University of South Florida  
College of Public Health

PHC 6517:  
"Cleaning, Disinfection, & Sterilization, Part 2"

our practice is the passion.

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## Steam Sterilization

- Based on factors of **steam, time, temperature, & pressure** [https://upload.wikimedia.org/wikipedia/commons/f/f7/AUTOCLAVE\\_4210.jpg](https://upload.wikimedia.org/wikipedia/commons/f/f7/AUTOCLAVE_4210.jpg)
- Oldest, safest, cheapest & best understood method
- Advantages:
  - non-toxic
  - readily available
  - fairly easy to control
  - consistent
  - reliable



[https://commons.wikimedia.org/wiki/File:Example\\_Autoclave.jpg](https://commons.wikimedia.org/wiki/File:Example_Autoclave.jpg)

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## Steam Sterilization Requires:

- Biological monitors (*Geobacillus stearothermophilus*) weekly & with every implantable load
- Use of chemical indicators with each item sterilized
- Recorded temperature of each load



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## Steam Sterilizer Types

- Gravity displacement autoclave** - (*steam admitted at top & forces air out of bottom*)
  - for laboratory media, water, pharmaceutical products, infectious wastes, non-porous articles
- High-speed prevacuum sterilizer** (*can be used for porous loads*)

# 2

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## Steam Sterilization Cycles



- 121 C (250° F) for 30 minutes** in *gravity displacement* sterilizer
- 132 °C (270° F) for 4 minutes** in *pre-vacuum sterilizer*

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## Dry Heat Sterilizer



- Kill organisms by oxidizing cell constituents
- Advantages:** dry heat penetrates well, does not corrode metal/sharp objects, is non-toxic, & ↓ cost
- Disadvantages:** dry heat penetrates slowly & kills microorganisms slowly
- Use only for materials that might be damaged or impenetrable to moist heat
- Examples:** powders, petroleum products, sharp instruments [https://commons.wikimedia.org/wiki/File:Dry\\_sterilizer\\_-\\_Autoclave.JPG](https://commons.wikimedia.org/wiki/File:Dry_sterilizer_-_Autoclave.JPG)

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## Dry Heat Cycles & Monitors



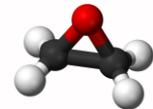
- 170°C (340°F) for 60 minutes
- 160°C (320°F) for 120 minutes
- 150°C (300°F) for 150 minutes
- Use biological indicators *Bacillus atrophaeus* spores

[https://en.wikipedia.org/wiki/Sterilization\\_\(microbiology\)](https://en.wikipedia.org/wiki/Sterilization_(microbiology))

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## Ethylene Oxide (ETO) Sterilizer

### Structure of ETO



<https://upload.wikimedia.org/wikipedia/commons/0/04/Ethylene-oxide-3D-balls.png>

- ETO is colorless, odorless, flammable, explosive gas
- Commonly used to sterilize objects that **cannot be steam sterilized**
- Function of **gas concentration, temp, humidity & exposure time**
- Inactivates all microorganisms

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## ETO Sterilizer



- **Primary advantage:** can sterilize heat or moisture-sensitive medical equipment without destroying them
- **Disadvantages:** lengthy cycle time, high cost, potential hazards to patients & staff
- **Another disadvantage:** requires aeration time for 8-12 hours

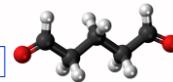


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## Chemical Disinfectants/Sterilants

<https://en.wikipedia.org/wiki/Barbicide>

### Glutaraldehyde



- Chemical sterilant is disinfectant or germicide used to destroy all forms of microbial life, including spores (**fungal & bacterial**)
- **NOTE: Depending on exposure or contact time**, some types of germicides can be used for either **disinfection or sterilization\***

[https://commons.wikimedia.org/wiki/File:Glutaraldehyde\\_3D\\_ball.png](https://commons.wikimedia.org/wiki/File:Glutaraldehyde_3D_ball.png)

\*= very important point

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## Monitoring Effectiveness

SR#2



<https://en.wikipedia.org/wiki/Endoscopy>

Some outbreaks of TB & other **gram negatives** linked to inadequate disinfection of scopes

AKA "Automatic Endoscope Reprocessors or AERs"

Monitoring includes:  
-Mechanical Indicators  
-Biological Indicators  
-Chemical Indicators

Inadequate cleaning of lumens, dilution, when not allowed to dry, not changing agent, rinsing

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## Monitoring Sterilization: Mechanical Indicators

### Steam Sterilization

### ETO Sterilization

- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>• Daily assessment of cycle time &amp; temperature via printout</li> <li>• Daily assessment of pressure via pressure gauge</li> </ul> | <ul style="list-style-type: none"> <li>• Time, temperature, &amp; pressure recorders</li> <li>• Can <b>NOT</b> be routinely assessed in healthcare ETO sterilizers: <b>gas concentration &amp; humidity</b></li> </ul> |
|--|--|

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## Monitoring Sterilization: Biological Indicators (BIs)

- Used to monitor **steam, dry heat & ETO sterilizers**
- BIs made with spores of organisms
- Types used:
  - *Geobacillus stearothermophilus* for steam cycles
  - *Bacillus atrophaeus* for dry heat & ETO

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## Monitoring Sterilization: Chemical Indicators

- Provide **immediate indication** that one or more sterilization parameters have not been met
- **Parameters:** time, pressure, temperature, air leak
- **Do NOT** provide same degree of assurance as BIs
- Not recommended as substitute for BIs, **even if Class 6**

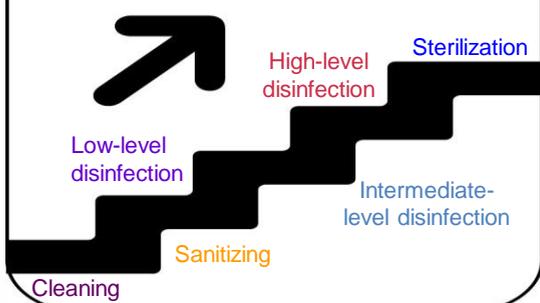


pH indicator strips

[https://en.wikipedia.org/wiki/PH\\_indicator](https://en.wikipedia.org/wiki/PH_indicator)

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## Levels of Decontamination



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## Factors Affecting Disinfection & Sterilization

- **Complexity** of device (e.g., hinged, lumens, surfaces)
- **# of organisms** present
- **Resistance** of microorganisms
- Amount & condition of **organic material** remaining on device
- **Method** of decontamination used
- **Concentration** of Disinfectant
- **Biofilms**



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## Complexity of Device: Simple



Bed Pan

<https://commons.wikimedia.org/wiki/File:Image-Oval-steel.jpg>

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## More Complicated

- Having more **surfaces**
- Having **hinges**
- Having more **parts**



[https://commons.wikimedia.org/wiki/File:Surgical\\_Instruments\\_01.jpg](https://commons.wikimedia.org/wiki/File:Surgical_Instruments_01.jpg)

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## Very Complicated

- Having *lumens* (e.g., scopes)

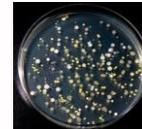


<https://commons.wikimedia.org/wiki/File:Bronkoskop.jpg>

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## Bioburden

- Number & types of viable (living) organisms which contaminate an article
  - “Bio-load”
  - “Microbial load”
- When measured, expressed as total count of bacterial & fungal per single colony-forming unit per single item

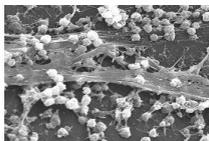


<https://www.flickr.com/photos/cdepa2/3372727630>

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## Biofilms

1. Thick mass of cells & extracellular materials
2. *Microbial communities* that can NOT be easily removed
3. ↓ efficacy of sterilization



<https://en.wikipedia.org/wiki/Biofilm>

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## How Do you Know What Needs to Be Sterilized or Disinfected?



Earle H. Spaulding's Classification Scheme based on risk of infection

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## 3 Categories



- **Critical:** Objects that enter sterile tissue or vascular system- *must be sterile*
- **Semi-critical:** Objects that contact mucous membranes or non-intact skin- *must be high-level disinfected*
- **Non-critical:** Objects that contact intact skin but not mucous membranes- *low level disinfection*

**Contact times of chemical sterilants important determinant**

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## Critical Items

- Surgical instruments
- Implants
- Needles
- Cardiac catheters
- Urinary catheters

### Require sterilization, by:

- Steam
- ETO or low temperature sterilization
- Rarely with chemical sterilants
  - Greater than 2.4% glutaraldehyde
  - 7.5% stabilized hydrogen peroxide
  - 0.2% peracetic acid
  - Mixed formulations

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## Critical Items: Sterilization



[https://en.wikipedia.org/wiki/Hypodermic\\_needle](https://en.wikipedia.org/wiki/Hypodermic_needle)



<https://pixabay.com/en/dentist-dental-tools-scalpel-teeth-114266/>

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## Semicritical

- Endoscopes
- Respiratory therapy equipment
- Anesthesia equipment

*Steam sterilization preferred method of between-patient processing of heat-stable medical instruments*

Require at least **high-level disinfection** with:

- wet pasteurization
- chemical disinfection:
  - Glutaraldehyde
  - hydrogen peroxide
  - Ortho-phthaldehyde
  - peracetic acid with hydrogen peroxide

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## Semi-critical Items



[https://en.wikipedia.org/wiki/Mechanical\\_ventilation#/media/File:Respiratory\\_therapist.jpg](https://en.wikipedia.org/wiki/Mechanical_ventilation#/media/File:Respiratory_therapist.jpg)



<https://en.wikipedia.org/wiki/Laryngoscopy>

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## Semi-Critical Items: Additional Recommendations

- Engage in ongoing surveillance to identify potential device-related outbreaks



<https://www.flickr.com/photos/dave dugdale/5099605109>

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## Non-critical

- Bedpans
- Blood pressure cuffs
- Stethoscopes
- Crutches
- Bedrails
- Linens
- Bedside tables
- Furniture

Require **low-level disinfection** with the following disinfectants:

- ethyl or isopropyl alcohol
- Sodium hypochlorite (100 ppm)
- phenolic, iodophor, & quaternary ammonium germicidal detergent solutions

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## Noncritical Items



<https://www.flickr.com/photos/jeffidair/47573155>

[https://en.wikipedia.org/wiki/Mop\\_bucket\\_cart](https://en.wikipedia.org/wiki/Mop_bucket_cart)



<http://www.public-domain-image.com/free-images/science/medical-science/stethoscope/attachment/stethoscope>

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## Disinfectants



- Alcohols
- Chlorine & chlorine compounds
- Ortho-phthaldehyde
- Glutaraldehyde
- Hydrogen peroxide
- Peracetic acid
- Phenolics
- Quaternary ammonium compounds
- Iodophors

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## Sterilization vs. Disinfection

### • Sterilization

- Destroys or eliminates all forms of microbial life

– Sporicidal

- Prions require specific procedure

### • Disinfection

- Eliminates many/ all pathogenic microorganisms, except bacterial spores, on inanimate objects

– NOT sporicidal

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## Issues

- Which work on what organisms
- Biohazards
- Patient populations (*e.g., phenolics & bassinets*)
- Presence of organic materials
- Must follow recommended contact time



[https://www.flickr.com/photos/go\\_greenier\\_oz/435609074](https://www.flickr.com/photos/go_greenier_oz/435609074)

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## Processing Patient Care Equipment

- Objects contaminated with:
  - Bloodborne Pathogens
  - Antibiotic-Resistant Organisms
  - Emerging Pathogens
  - Bioterrorist Agents



- Use sterilization or disinfection guidelines *already outlined*

[https://commons.wikimedia.org/wiki/File:Operating\\_room\\_for\\_captives\\_-\\_c.jpg](https://commons.wikimedia.org/wiki/File:Operating_room_for_captives_-_c.jpg)

- No changes except for prions

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Figure 1. Decreasing order of resistance of microorganisms to disinfection sterilization & the level of disinfection or sterilization.

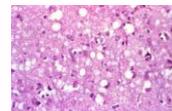
Source: Required Reading #1, page 108

### Resistant Level

- | Prions (Creutzfeldt-Jakob Disease) **Prion reprocessing**
- | Bacterial spores (*Bacillus anthracis*) **Sterilization**
- | Coccidia (*Cryptosporidium*)
- | Mycobacteria (*M. tuberculosis*, *M. terrae*) **High**
- | Nonlipid or small viruses (polio, coxsackie) **Intermediate**
- | Fungi (*Aspergillus*, *Candida*)
- | Vegetative bacteria (*S. aureus*, *P. aeruginosa*) **Low**
- ↓ Lipid or medium-sized viruses (HIV, herpes, HBV) **Susceptible**

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## Prions



<http://pathology.mc.duke.edu/neuropath/CNSlecture2/c4.jpg>

- Creutzfeldt-Jakob Disease (CJD)
- Bovine spongiform encephalopathy (BSE) in cattle aka “Mad cow disease”
- Neurodegenerative diseases in sheep & goats

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## Special Reprocessing for Prions

- **Option 1-** autoclave at 134°C for 18 minutes in a prevacuum sterilizer
- **Option 2-** autoclave at 132°C for 1 hour in a gravity displacement sterilizer
- **Option 3-** immerse in NaOH & transfer to autoclave
- **Option 4-** immersion, gravity displacement, cleaning, & sterilization

See details in slide transcript

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## W.H.O. Guidelines

- WHO infection control guidelines for transmissible spongiform encephalopathies
- Report of a WHO consultation, Geneva, Switzerland, 23-26 March 1999



Available here:

<http://www.who.int/csr/resources/publications/bse/whodocscsgraph2003.pdf>

World Health Organization

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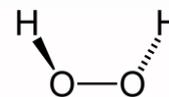
## More Options

- OPA- Ortho-phthalaldehyde
- Surfacine
- Ozone
- Endoclenz
- Attest ETO rapid readout
- Plasma sterilizer

See transcript & readings for more details

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## Hydrogen Peroxide Vapor Systems



- **Indications:** room decontamination, low temperature sterilization

<https://upload.wikimedia.org/wikipedia/commons/3/32/Hydrogen-peroxide-2D.png>

- **Advantages:** surface & equipment decontaminated, decreases incidence of disease (C. Diff), residue-free, uniform distribution, useful for complex items, efficacious against wide range of pathogens
- **Disadvantages:** only done for terminal clean, rapid environmental recontamination, patient removal required, time, HVAC disabled, room taped, environment only contributes ~5% to disease transmission

See RR# 2

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## Antiseptic

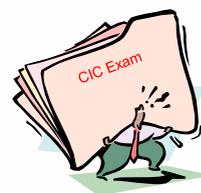
- Chemical germicide that prevents or arrests growth/action of organisms on **living tissue** either by inhibiting their activity or destroying them
- **Should NOT be used on inanimate objects**
- Registered & regulated as drugs (**FDA**)

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## Conclusions

- Covered numerous principles & information
- Required Readings
- Supplemental Readings

Need to know this material in more detail for CIC exam



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