Reprocessing Validations: Disinfection and Sterilization

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Reusable Medical Devices
Process Overview – Reusable Devices

- Thorough cleaning
- Sterilization
- Disinfection
Disinfection Validations
Why do Disinfection Validations?

Disinfection must be performed if the device is unable to be sterilized.

Disinfection maybe applicable for facilities where method of sterilization is not available.

Europe?
Disinfection Validations

Manual
• Soaking
• Spraying/Wiping

Automated
• Endoscopes (AER)

Thermal
• Automated
  • Thermocouples ($A_0$)
  • Ampoules (Log reduction)
• Pasteurization
Disinfection levels and acceptance criteria

Based on Spaulding Classification

**Critical Devices** =
**Sterilization** – SAL $10^{-6}$

**High Level Disinfection**
- Mycobacterium – 6 Log reduction

**Semi-Critical Devices** =
**High Level Disinfection**
- Mycobacterium – 6 Log reduction

**Non-Critical Devices** =
**Intermediate/Low Level Disinfection**
- Mycobacterium – 3 Log reduction
- Four Vegetative Organisms – 6 log reduction separately
<table>
<thead>
<tr>
<th>Patient Contact</th>
<th>Examples</th>
<th>Device Classification</th>
<th>Disinfection Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intact skin</td>
<td>Non-critical</td>
<td>Low level or intermediate level disinfection</td>
<td></td>
</tr>
<tr>
<td>Mucous membranes or non-intact skin</td>
<td>Semi-Critical</td>
<td>High level disinfection</td>
<td></td>
</tr>
<tr>
<td>Sterile areas of the body including blood contact</td>
<td>Critical</td>
<td>Sterilization</td>
<td></td>
</tr>
</tbody>
</table>
## Thermal Disinfection – Washer Disinfector (WD)

<table>
<thead>
<tr>
<th>Category</th>
<th>( A_0 ) value</th>
<th>Microbial (Ampoule)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invasive – Semi-critical devices</td>
<td>&gt; 3000 ( (90^\circ C \text{ at 5 minutes}) )</td>
<td>High level disinfection</td>
</tr>
<tr>
<td>Non – Invasive (devices that will be sterilized after disinfection)</td>
<td>&gt; 600 ( (90^\circ C \text{ at 1 minutes}) )</td>
<td>Intermediate level disinfection</td>
</tr>
<tr>
<td>Intact skin</td>
<td>&gt; 60 ( (70^\circ C \text{ at 10 minutes}) )</td>
<td>Low level disinfection</td>
</tr>
</tbody>
</table>
Sample size and controls

- **Positive control**
  - 1 sample
    - Inoculated
      - unprocessed

- **Test article**
  - 3 samples
    - Inoculated
    - Processed

- **Neutralization**
  - 1 sample
    - Processed

- **Cytotoxicity**
  - 1-3 samples
    - processed
Inoculation Method

- Direct inoculation
- One test soil
Phases of Disinfection Validation

Neutralization Testing

DISINFECTION VALIDATION

Cytotoxicity Testing

Bio Load Reduction Evaluation

K. pneumoniae and P. aeruginosa at 48 hrs in a mixed suspension
High Level Disinfection

High-Level Disinfection usually is performed through soaking the device for a specified time.

- Glutaraldehyde solutions (Cidex)
- Hydrogen peroxide based disinfectants
- Peracetic acid based disinfectants

https://www.fda.gov/medicaldevices/deviceregulationandguidance/reprocessingofreusablemedicaldevices/ucm437347.htm
Intermediate and Low Level disinfections usually are performed by wiping or spraying the devices, occasionally by soaking.

- Isopropyl alcohol (70% IPA)
- Quaternary ammonium compounds
- Sani-cloth, CaviCide Wipes/spray
- Hypochlorite (Chlorine)
  - Bleach (at different concentrations)

https://www.epa.gov/sites/production/files/2018-01/documents/2018.05.01.liste_.pdf
Disinfection instructions – ISO 17664:2017

Required as part of the reprocessing in the EU

<table>
<thead>
<tr>
<th></th>
<th>US</th>
<th>EU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glutaraldehyde Solutions</td>
<td>Peracetic Acid/ Hydrogen Peroxide</td>
<td></td>
</tr>
</tbody>
</table>

Both types of disinfectants need to be validated if marketed in both EU and US
Methods of Sterilization

- Steam
- Ethylene Oxide
- Dry Heat
- Liquid Chemical
- STERRAD®
- Radiation
Benefits to steam under pressure:

- Most widely used method in health care setting
- Dependable
- Non-toxic
- Rapid killing action
- Relatively inexpensive
Product design considerations for steam sterilization

- Withstand moisture
- Withstand changes in pressure and high temperatures
- Designed for adequate air removal and steam penetration
- Maintain functionality after sterilization
Sterilization Considerations

Device Design

- Material of device heats up quickly and remains hot
- Limit blind holes, dead-ended lumens, or insulated lumens
- Cannulas and entire device allows for air removal and steam penetration

Tray Design

- Reduce mass (<25 pounds)
- Proper steam flow throughout tray
- Holders have limited contact with device
- Holders do not block steam
- Holders allow devices to be in unlocked and open position
- Mass is distributed throughout tray
- Devices are not stacked on each other
Samples size

Sterilization tray

1 tray

Device

3 devices
Most resistant organism: *Geobacillus stearothermophilus*

Overkill Method is used to determine the Sterility Assurance Level (SAL) assurance level of $10^{-6}$.

BIs placed in the most difficult-to-sterilize areas:
- Lumens
- Mated surfaces
- Cannulas
- Heat Sink Areas
Steam sterilization validation steps

1. Sterility Assurance level (SAL) validation with half cycle parameters
2. Dry time validation with full cycle parameters
3. Temperature profiling
SAL Validation

- Selection of inoculation locations / method
- Product inoculation
- Package
- Program half cycle time and process
- Sterility test
- Score for growth
Product inoculation

- BI Strips
- Inoculated sutures and wires
Types of packaging

Pouch
- Typically used for light weight medical devices

Sterilization wrap
- Must allow for steam penetration and adequate air removal and drying

Rigid container
- Come in many shapes, sizes, and materials
- May contain perforated openings for ease of sterilization
- Additional testing may be applicable
Sterilization Validation – Validation Method

Sterilization Cycle

<table>
<thead>
<tr>
<th>Sterilizer Type:</th>
<th>Prevacuum</th>
<th>Prevacuum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preconditioning Pulses:</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Minimum Temperature:</td>
<td>132°C</td>
<td>135°C</td>
</tr>
<tr>
<td>Half Cycle Time:</td>
<td>2 minutes</td>
<td>1.5 minutes</td>
</tr>
<tr>
<td>Minimum Dry Time:</td>
<td>0 minutes</td>
<td>0 minutes</td>
</tr>
</tbody>
</table>

BI sterility testing

Incubation
• BIs and inoculated product are incubated at 55-60°C for a minimum of 7 days
• BIs and inoculated product are scored for growth of the indicator organism
<table>
<thead>
<tr>
<th>Identification</th>
<th>Run #1</th>
<th>Run #2</th>
<th>Run #3</th>
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</thead>
<tbody>
<tr>
<td>Site 1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Site 2</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Site 3</td>
<td>0</td>
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<td>Site 4</td>
<td>0</td>
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<td>Site 5</td>
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<td>Site 6</td>
<td>0</td>
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<td>Site 7</td>
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<td>Site 8</td>
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<td>0</td>
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<td>Site 18</td>
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<td>Site 19</td>
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<td>Site 22</td>
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<tr>
<td>Site 23</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Positive Controls</td>
<td>+, +</td>
<td>+, +</td>
<td>+, +</td>
</tr>
<tr>
<td>Negative Control</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Environmental Control</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Prevacuum Half Cycle:**
0 = No Growth
+ = Growth
Dry Time Validation

1. Prepare and weigh packaging
2. Package the Device(s)/Tray(s)
3. Program full cycle time and process
4. Visual inspection for moisture on packaging and product
5. Re-weigh packaging
Dry Time Validation Acceptance Criteria

All validation cycles must be within specifications

Packaging and products must pass visual inspection with no moisture observed

Packaging weight gain cannot exceed 3%

\[
\frac{\text{Post weight} - \text{pre weight}}{\text{pre weight}} \times 100 = \text{weight gain percentage}
\]
Temperature Profiling

1. Program thermocouples and place inside product and chamber
2. Package the product
3. Place thermocouples in the chamber
4. Program full cycle time and process
5. Download thermocouple data
Metal vs. Silicon Device Temperature Profiling

Prevacuum, 132 degrees Celsius, 4/0
Metal Device (355.1 grams)
Product & Chamber Temperature Profile

Prevacuum, 132 degrees Celsius, 4/0
Silicone Device (360.2 grams)
Product & Chamber Temperature Profile
Steam enters chamber and air is displaced through a vent until the specified temperature and pressure is achieved.

Used for products that allow effective air removal and steam contact.

Gravity-Displacement – PHASING OUT

Sterilization Phases:
- Purge/Charge
- Exposure
- Exhaust
- Drying
- Vacuum Relief

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Effectively removes the air from the chamber and replaces it with steam.

Air removal by using a series or pulsing of vacuums.

Used for products consisting of porous materials having cavities where air is difficult to remove.

Sterilization phases:
- Air removal/conditioning
- Charge
- Exposure
- Exhaust
- Drying
- Vacuum relief
Recent Sterilization Guidance

- Sterilizers
  - Steam, EO, STERRAD, Dry Heat
- Accessories
  - Biological Indicators, Chemical Indicators, Packaging

- Parameters from AAMI TIR12
- No more extended cycles
<table>
<thead>
<tr>
<th>Item</th>
<th>132°C (270°F)</th>
<th>135°C (275°F)</th>
<th>Drying Times</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wrapped Instruments</td>
<td>4 min</td>
<td></td>
<td>20-30 min</td>
</tr>
<tr>
<td>Textile Packs</td>
<td>4 min</td>
<td></td>
<td>5-20 min</td>
</tr>
<tr>
<td>Wrapped Utensils</td>
<td>4 min</td>
<td></td>
<td>20 min</td>
</tr>
<tr>
<td>Unwrapped Nonporous Items (e.g. instruments)</td>
<td>3 min</td>
<td>3 min</td>
<td>NA</td>
</tr>
<tr>
<td>Unwrapped Nonporous and Porous Items in a Mixed Load</td>
<td>4 min</td>
<td>3 min</td>
<td>NA</td>
</tr>
</tbody>
</table>
Some current process parameters for reprocessing in CSSD in EU

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>STEAM STERILIZATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switzerland</td>
<td>18 minutes</td>
</tr>
<tr>
<td>Turkey</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Belgium</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Austria</td>
<td>5 minutes</td>
</tr>
<tr>
<td>France</td>
<td>18 minutes</td>
</tr>
<tr>
<td>Germany</td>
<td>5 minutes</td>
</tr>
<tr>
<td>England</td>
<td>3 minutes</td>
</tr>
<tr>
<td>Spain</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Hungary</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Portugal</td>
<td>4 minutes</td>
</tr>
<tr>
<td>Netherlands</td>
<td>3 minutes</td>
</tr>
</tbody>
</table>

134°C
Guidance from FDA

Reprocessing Medical Devices in Health care Settings: Validation Methods and Labeling Guidance for Industry and Food and Drug Administration Staff

Published 17 Mar 2015 (Revised in 2017)

References on NL Website

- Cleaning validations of reusable medical devices: https://www.nelsonlabs.com/Test/Cleaning-Validations-of-Reusable-Medical-Devices
- Sterilization validations of reusable medical devices: https://www.nelsonlabs.com/Test/Sterilization-Validations-Device-or-Trays
Reference Standards

**Guidance for Industry and FDA Staff** – Reprocessing Medical Devices in Health Care Settings: Validation Methods and Labeling – March 17, 2015, Revised 2017

**AAMI TIR12** Designing, testing, and labeling reusable medical devices for reprocessing in health care facilities: A guide for medical device manufacturers

**AAMI TIR30** A compendium of processes, materials, test methods, and acceptance criteria for cleaning reusable medical devices

**ANSI/AAMI TIR55** – Human Factors Engineering for processing medical devices

**AAMI TIR34** – Water for Reprocessing of Medical Devices

**AAMI/AAMI ST81** – Sterilization of Medical Devices, Information to be provided by the manufacturer for the processing of resterilizable medical devices.

**ANSI/AAMI ST79** – Comprehensive guide to Steam Sterilization and sterility assurance in health care facilities

**ANSI/AAMI ST58** Chemical Sterilization and high level disinfection in health care facilities

**ANSI/AAMI ST9** – Comprehensive guide to flexible and semi-rigid Endoscope Reprocessing in health care facilities

**ANSI/AAMI ST77** Containment devices for reusable medical device sterilization

**ANSI/AAMI ST67** Sterilization of health care products – Requirements for products labeled “STERILE”

**ASTM F3208** – Standard test soils for validation of cleaning methods for reusable medical devices
Reference Standards

ISO 17664: Processing of health care products – information to be provided by the medical device manufacturer for the processing of medical devices

ISO 17665-1: Sterilization of health care products -- Moist heat -- Part 1: Requirements for the development, validation and routine control of a sterilization process for medical devices


ISO 17665-3: Sterilization of health care products -- Moist heat -- Part 3: Guidance on the designation of a medical device to a product family and processing category for steam sterilization

ISO 15883: series – Washer-disinfectors


ISO 14937: Sterilization of health care products – General requirements for characterization of a sterilizing agent and the development, validation, and routine control of a sterilization process for medical devices

EN 285: Sterilization - Steam sterilizers - Large sterilizers

EN 556-2: Sterilization or medical devices – Requirements for medical devices to be designated “STERILE” – Requirements for aseptically processed medical devices

PDA Technical Report No. 1: Validation of moist heat sterilization processes: Cycle design, development, qualification, and ongoing control
Thank You!

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