The impact of disinfectants on residue formation on endoscope surfaces

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Topics

• Objectives

• Options for active substances

• Impact of residue formation depending on active substance

• Conclusions
Objectives

Focus on residue formation by interaction between disinfecting agents and proteins

Two questions will be discussed

A) Are there large molecules formed?
B) Does the disinfecting agent support the link between large molecule and the endoscope surface - fixation?
Options for Active Substances

Range of effectiveness of various disinfecting agents

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<th>Peroxides</th>
<th>Aldehydes</th>
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<th>Phenols</th>
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“Reactive effective agents”      Non-reactive effective agents

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October 17, 2014
Options for Active Substances

Active Substances used for endoscope disinfection:

**Aldehydes:**
- ✓ Glutaraldehyde
- ✓ o-Phthalaldehyde (OPA)

**Oxidising Substances:**
- ✓ Chlorine dioxide
- ✓ Hypochlorous acid
- ✓ Hydrogen peroxide
- ✓ Buffered peracetic acid
Options for Active Substances

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Glutaraldehyde

Formation of large molecules

Reactions between glutaraldehyde and proteins:

- Glutaraldehyde is a protein cross-linker.
- Large molecules are formed.
Glutaraldehyde
Fixation of large molecules

- Deposits on the outer surfaces of insertion tube are observed.

Magnification: 1000
Magnification: 275
Source: M. Kamer, Dr. Weigert
Glutaraldehyde
Fixation of large molecules

Deposits on the other surfaces of insertion tube are observed.

Residues in channels are observed as well.

Reason:
Insufficient protein removal after use and before disinfection with glutaraldehyde?

Question:
Why is the residues limited on the area of insertion tube coming in contact with the patient?
Glutaraldehyde Fixation of large molecules

Explanation:

- Glutaraldehyde adsorbs in the disinfection phase in small amount on the plastic surfaces and will not be complete removed by the following final rinsing.
- Absorbed glutaraldehyde reacts with proteins during the endoscope contact with the patient.
- Formed large molecules can not totally removed in the following reprocessing procedure.
- Residue layers are built-up in several reprocessing cycles.
Glutaraldehyde Summary

- Consider residue formation by fixation of large glutaraldehyde-protein molecules during endoscope use.

- Strong focus on
  - improved final rinsing
  - mechanical support in the cleaning phase due to difficult to remove larger molecules
o-Phthalaldehyde (OPA)

**Formation of large molecules:**
- OPA reacts with proteins
- Probability to form large molecules is much lower than glutaraldehyde

**Fixation of large molecules:**
- Likelihood low
- Less experience
- Should be investigated
Oxidising Acids
Impact of pH-value

Example: Hydrochloric acid

Oxidising acids:

Hypochlorous acid ↔ Buffered hypochlorous acid ↔ Sodium hypochlorite

Peracetic acid ↔ Buffered peracetic acid ↔ Sodium peracetate
Oxidising Acids
Impact of pH-value

Example: Hydrochloric acid

Oxidising acids used in endoscope disinfection:

Hypochlorous acid ↔ Buffered hypochlorous acid ↔ Sodium hypochlorite

Peracetic acid ↔ Buffered peracetic acid ↔ Sodium peracetate
Hypochlorous acid

Formation of large molecules:

- Acid related protein coagulation is possible.
- Intermolecular reactions have been observed with milk proteins.

Fixation of large molecules:

Likelihood low because of:

- low concentration of active agent
- fast reaction between hypochlorous acid and proteins
- device detect the lowest accepted concentration
- decomposition of active agent – no adsorption
1902 First publication on the microbiological effect of peracetic acid by Frier and Novy

1949 Comparison of 23 antimicrobial effective agents
   – Peracetic acid is the most effective substance

1955 First use of peracetic acid in raising experimental animals free of germs

1960 - 70 Ground-laying experiments on stability, analysis and material compatibility in work groups in Erfurt and Prague

1970 Introduction of first peracetate-based antimicrobial cleaner for surgical instruments to the market
Peracetic acid and its salts
Applications in the medical field

- Antimicrobial cleaner for surgical instruments
  pH-value: alkaline

- Disinfection of haemodialysis devices
  pH-value: acid

- Chemo-thermal disinfection procedure for hospital linen tested by RKI
  pH-value: alkaline

- Hand and skin disinfection
  pH-value: buffered

- Disinfection of medical instruments, including flexible endoscopes
  pH-value: buffered
Peracetic acid and its salts pH-value impact

Effectiveness

Intensity of odor

Buffered Peracetic Acid

Material compatibility

User safety

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Buffered peracetic acid
Formation of large molecules

Free-radical reaction with proteins

Decomposition of protein chains by peracetic acid

Buffered peracetic acid
Fixation of large molecules

- One lab study with artificial blood described the fixation of large protein molecules (fibrin) on stainless steel plates.

- Fixation of fibrin could not be observed on synthetic surfaces in other lab studies.

- Field studies and practical experience in endoscope reprocessing show no residue formation on endoscope surfaces.
Buffered peracetic acid
Remove of glutaraldehyde-protein deposits

Endoscopy channels after routine reprocessing with glutaraldehyde followed by cycles with buffered peracetic acid:

- After routine disinfection with glutaraldehyde
- After 30 cycles with peracetic acid and no mechanical support
- After 30 cycles with peracetic acid and with mechanical support

Meyer B. HygMed 2004; 29: 106-109
Buffered peracetic acid
Remove of glutaraldehyde-protein deposits

Practical experience:

- Deposit remove on outer surfaces after couple of reprocessing cycles
  - Brightening the ring markers

- Stiffness of brushing during the transition period
  - Deposits are removed
Buffered peracetic acid

Summary

- Because of steric hindrance, intermolecular reactions plays a minor role in interaction with proteins.
- Formation of bigger molecules are not expected.
- Even though lab study show fixation of large molecules on stainless steel plates, comparable effects on synthetic materials are not observed.  
  - no residue formation under reprocessing conditions in the field
- Glutaraldehyde/Protein deposits are removed by repeated disinfection with buffered peracetic acid.
Conclusions

- Glutaraldehyde cross-link proteins
  - Risk of residue formation should be considered.
  - Enhanced rinsing, brushing and cleaning is required.

- Minor probability for protein cross-link and fixation of formed molecules in case of o-phthalaldehyde (OPA), hypochlorous acid and buffered peracetic acid

- Glutaraldehyde/Protein deposits can be removed by repeated treatment/disinfection with buffered peracetic acid
Are you okay?

Thank you for your attention!