Endoscopy Reprocessing: Current Issues and Future Perspectives

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Former Director, Hospital Epidemiology, Occupational Health and Safety, UNC Hospitals, Chapel Hill, NC (1979-2017)
DISCLOSURES
2020-2021

• Consultations
  ■ PDI

• Honoraria
  ■ ASP, PDI
Our Responsibility to the Future

Prevent All Infectious Disease Transmission by Medical Devices in 5 years
EH Spaulding believed that how an object will be disinfected depended on the object’s intended use (developed 1968).

**CRITICAL** - medical/surgical devices which enter normally sterile tissue or the vascular system or through which blood flows should be **sterile**.

**SEMICRITICAL** - medical devices that touch mucous membranes or skin that is not intact require a disinfection process (**high-level disinfection** [HLD]) that kills all microorganisms but high numbers of bacterial spores.

**NONCRITICAL** - medical devices that touch only intact skin require **low-level disinfection**.
Sterilization

Enormous Margin of Safety!

100 quadrillion \((10^{17})\) margin of safety

Sterilization kills 1 trillion spores, washer/disinfector removes or inactivates 10-100 million; ~100 microbes on surgical instruments
# Infections/Outbreaks Associated with Semicritical Medical Devices


<table>
<thead>
<tr>
<th>Medical Device</th>
<th>No. Outbreaks/Infections</th>
<th>No. Outbreaks/Infections with Bloodborne Pathogens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaginal Probes</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ear-Nose-Throat Endoscopes</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Urologic instruments (e.g. cystoscopes)</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>Hysteroscopes</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Laryngoscopes</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Transrectal ultrasound guided prostate</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Applanation tonometers</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>TEE-Transesophageal echocardiogram</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>GI Endoscopes/Bronchoscopes</td>
<td>~130</td>
<td>3 (HBV-1 GI; HCV-2 GI; HIV-0)</td>
</tr>
</tbody>
</table>
Why does HLD fail to provide patient safety?
• Margin of safety with endoscope reprocessing minimal or non-existent
• Microbial load
  ◆ GI endoscopes contain $10^{7-10}$
  ◆ Cleaning results in 2-6 log$_{10}$ reduction
  ◆ High-level disinfection results in 4-6 log$_{10}$ reduction
  ◆ Results in a total 6-12 log$_{10}$ reduction of microbes
  ◆ Level of contamination after processing: 4 log$_{10}$ (maximum contamination, minimal cleaning/HLD)
• Complexity of endoscope and endoscope reprocessing
• Biofilms—may contribute to failure of endoscope reprocessing
Reason for Endoscope-Related Outbreaks


- Margin of safety with endoscope reprocessing minimal or non-existent
- Microbial load
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ENDOSCOPE REPROCESSING: CHALLENGES

Complex [elevator channel]-$10^7$-$10^8$ bacteria/endoscope

Surgical instruments-$<10^2$ bacteria
High-Level Disinfectants Are Effective (no exposure to HLD, no inactivation)

- Registration test for high-level disinfectants against healthcare pathogens, HLD (OPA, PA, etc.) effective
  - Carriers are etc. inoculated with the test organism (S. aureus, S. choleraesuis, P. aeruginosa) and then dried. After drying, the carrier is transferred to a disinfectant tube and immersed in the disinfectant for the contact time (e.g., 12 minutes).
  - Mycobacterium, CRE, viruses (SARS-CoV-2), MDRO, Candida auris
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FEATURES OF ENDOSCOPES THAT PREDISPOSE TO DISINFECTION FAILURES


- Heat labile
- Long, narrow lumens (3.5ft, 1-3mm)
- Right angle bends
- Rough or pitted surfaces
- Springs and valves
- Damaged channels may impede microbial exposure to HLD
- Heavily contaminated with pathogens, $10^{7-10}$
- Cleaning (2-6 log$_{10}$ reduction) and HLD (4-6 log$_{10}$ reduction) essential for patient safe instrument
NDM-producing E. coli recovered from elevator channel (elevator channel orients catheters, guide wires and accessories into the endoscope visual field; crevices difficult to access with cleaning brush and may impede effective reprocessing). Very high microbial load $10^{7-10}$. 
### Complexity of Endoscope Reprocessing

**Chua et al. Techniq Innov Gastro Endo 2021;23:190**

<table>
<thead>
<tr>
<th>Pre-Cleaning</th>
<th>Leak Testing</th>
<th>Manual Cleaning</th>
<th>Visual Inspection</th>
<th>HLD</th>
<th>Drying &amp; Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wipe insertion tube with detergent solution</td>
<td>Remove suction, air, water, &amp; biopsy valves</td>
<td>Immerse the endoscope into an appropriate detergent solution</td>
<td>Visual inspection should be performed throughout however particular attention prior to HLD.</td>
<td>Test and monitor the disinfectant according to manufacturer instructions.</td>
<td>Flush all channels with 70% to 90% ethyl or isopropyl alcohol.</td>
</tr>
<tr>
<td>Suction detergent solution through endoscope until visibly clear</td>
<td>Discard disposable parts</td>
<td>Wash the exterior of the endoscope by brushing and wiping while submerged.</td>
<td>Inspect for conditions that could affect disinfection process (cracks, retained debris)</td>
<td>Completely immerse the endoscope in a basin of high-level disinfectant.</td>
<td>Purge all channels with filtered compressed air.</td>
</tr>
<tr>
<td>Flush and manipulate the forcep elevator (duodenoscope or echoendoscope)</td>
<td>Attach leak tester and pressurize the endoscope before submerging in clear water. Do not use detergent.</td>
<td>Brush all reusable &amp; removable parts including valves, biopsy cover &amp; openings.</td>
<td>Use magnification &amp; adequate lighting to assist in visual inspection</td>
<td>Flush high-level disinfectant into all channels until it can be seen exiting opposite end.</td>
<td>Removal all channel adapters</td>
</tr>
<tr>
<td>Flush air and water channels</td>
<td>Perform leakage test. Flex distal end of endoscope in all directions and manipulate buttons.</td>
<td>Perform additional manufacture specific cleaning for duodenoscope elevator mechanisms, echoendoscopes, &amp; double channel endoscopes.</td>
<td>Use a camera or borescope for internal channels, if available</td>
<td>Cover soaking basin with tight fitting lid.</td>
<td>Dry exterior of endoscope with soft, clean, lint-free towel</td>
</tr>
<tr>
<td>Flush auxiliary water channels</td>
<td>Remove from sink or basin. Turn off and disconnect leak tester. Depressurize the endoscope and ensure the video cap is secure.</td>
<td>Flush all channels with detergent solution and soak the endoscope and its internal channels for a period specified by manufacturer.</td>
<td>Repeat manual cleaning as needed</td>
<td>Soak the endoscope for the required temperature and time using appropriate monitoring or automated HLD</td>
<td>Dry all removal parts and do not attach to endoscope during storage</td>
</tr>
<tr>
<td>Detach endoscope from light source and suction pump</td>
<td>Remove endoscope from service if leak is identified for repair or disposal.</td>
<td>Thoroughly rinse the endoscope and all removable parts with clean water.</td>
<td>Remove damaged endoscope from service for repair or disposal</td>
<td>Purge all channels with air before removing the endoscope from the high-level disinfectant</td>
<td>Use a system to identify which endoscope has been reprocessed (i.e. tagging)</td>
</tr>
<tr>
<td>Attach protective video cap</td>
<td>Transport to a dedicated reprocessing area in appropriate covered container</td>
<td>Purge water from all channels using forced air and dry exterior using lint free cloth</td>
<td>Purge water from all channels using forced air and dry exterior using lint free cloth.</td>
<td>Thoroughly rinse the endoscope and all removable parts with clean water.</td>
<td>Use storage cabinets that can be cleaned and disinfected with EPA registered high level disinfectant.</td>
</tr>
</tbody>
</table>

**Legend:**
- **HLD**: High-Level Disinfection
- **Drying & Storage**: Drying and Storage
Reprocessing Channeled Endoscopes Manually

Cystoscope- “completely immerse” in HLD (J Urology 2008.180:588)
Reprocessing Channeled Endoscopes Manually

Cystoscope-HLD perfused through lumen with syringe (luer locks onto port and syringe and lumen filled with HLD)
Reprocessing Channeled Endoscopes Manually

<table>
<thead>
<tr>
<th>Exposure Method</th>
<th>CRE (K. pneumoniae)</th>
<th>CRE (K. pneumoniae)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inoculum before HLD</td>
<td>Contamination after HLD</td>
</tr>
<tr>
<td>Passive HLD (immersed, not perfused)</td>
<td>3.2x10^8, 1.9x10^9, 4.1x10^8</td>
<td>3.1x10^8, 4.6x10^8, 1.0x10^8</td>
</tr>
<tr>
<td>Active HLD (perfused HLD into channel with syringe)</td>
<td>3.0x10^8, 9.2x10^8, 8.4x10^8</td>
<td>0, 0, 0</td>
</tr>
</tbody>
</table>

- Pathogens must have exposure to HLD for inactivation
- Immerse channeled flexible scope into HLD will not inactivate channel pathogens
- Completely immerse the endoscope in HLD and ensure all channels (e.g., hysteroscopes, cystoscopes) are perfused
- Air pressure in channel stronger than fluid pressure at fluid-air interface
Reason for Endoscope-Related Outbreaks

• Margin of safety with endoscope reprocessing minimal or non-existent
• Microbial load
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• Biofilms—may contribute to failure of endoscope reprocessing
Three types of biofilm

- Traditional hydrated biofilm (water content 90%)
- Build-up biofilm—could occur in endoscope channels; layers of dried organic matrix and embedded organisms
- Dry surface biofilm-heterogenous accumulation of organisms and other material in a dry matrix (water content 61%)
  - Raises questions about the inactivation of microbes with a dry surface biofilm by currently used cleaning/disinfecting methods
Figure 1 Comparison of traditional to cyclic build-up biofilm

[Diagram showing stages of biofilm development and cyclic build-up biofilm]

Build-Up Biofilm
(no evidence of biofilm development when MIFU/guidelines followed; organisms in organic matrix)

Pajkos et al. J Hosp Infect 2004;58:224
High-Level Disinfection
No Margin of Safety

0 margin of safety

Microbial contamination $10^7$-$10^{10}$: compliant with reprocessing guidelines 10,000 microbes after reprocessing:
maximum contamination, minimal cleaning ($10^2$)/HLD ($10^4$)
Evidence-Based Recommendation for Sterilization of Endoscopes

(FDA Panel Recommendation for Duodenoscopes, May 2015; more peer-reviewed publications (>150) for the need for shifting from disinfection to sterilization than any other recommendation of AAMI, CDC [HICPAC], SHEA, APIC, SGNA, ASGE)

>130 plus endoscope-related outbreaks

GI endoscope contamination rates of 20-40% after HLD

Scope commonly have disruptive/irregular surfaces

>50,000 patient exposures involving HLD
Gastrointestinal Endoscopes
A Need to Shift From Disinfection to Sterilization?

William A. Rutala, PhD, MPH; David J. Weber, MD, MPH

More than 10 million gastrointestinal endoscopic procedures are performed annually in the United States for diagnostic purposes, therapeutic interventions, or both. Because gastrointestinal endoscopes contact mucosal surfaces, use of a contaminated endoscope may lead to patient-to-patient transmission of potential pathogens with a subsequent risk of infection.

In this issue of JAMA, Epstein and colleagues report findings from their investigation of a cluster of New Delhi metallo-
β-lactamase (NDM)-producing Escherichia coli associated with gastrointestinal endoscopy that occurred from March 2013 to July 2013 in a single hospital in northeastern Illinois. During the 5-month period, 9 pa-

First, endoscopes are semicritical devices, which contact mucous membranes or nonintact skin, and require at least high-level disinfection. High-level disinfection achieves complete elimination of all microorganisms, except for small numbers of bacterial spores. Because flexible gastrointestinal endoscopic instruments are heat labile, only high-level disinfection with chemical agents or low-temperature sterilization technologies are possible. However, no low-temperature sterilization technology is US Food and Drug Administration (FDA)-cleared for gastrointestinal endoscopes such as duodenoscopes.

Second, more health care-associated outbreaks and clusters of infection have been linked to contaminated endoscopes than to any other medical device. However, until now,
What Is the Public Health Benefit?
No ERCP-Related Infections

Margin of Safety—currently nonexistent; sterilization will provide a safety margin ($\sim 6 \log_{10}$). To prevent infections, all duodenoscopes should be devoid of microbial contamination.

HLD ($\geq 6 \log_{10}$ reduction) vs

Sterilization ($12 \log_{10}$ reduction = SAL $10^{-6}$)
What Should We Do Now?
Supplemental Measures to Reduce Infection Risk

Hospitals performing ERCPs should do one of the following; FDA adopted these recommendations

- Ethylene oxide sterilization after high level disinfection with periodic microbiologic surveillance
- Double high-level disinfection with periodic microbiologic surveillance
- High-level disinfection with scope quarantine until negative culture
- Liquid chemical sterilant processing system using peracetic acid (rinsed with extensively treated potable water) with periodic microbiologic surveillance
- High-level disinfection with periodic microbiologic surveillance
Did supplemental measures work?
Hospitals performing ERCPs should do one of the following; FDA adopted these recommendations

- Ethylene oxide sterilization after high level disinfection with periodic microbiologic surveillance
- **Double high-level disinfection** with periodic microbiologic surveillance
- High-level disinfection with scope quarantine until negative culture
- Liquid chemical sterilant processing system using peracetic acid (rinsed with extensively treated potable water) with periodic microbiologic surveillance
- High-level disinfection with periodic microbiologic surveillance
Double HLD demonstrated no benefit over single HLD; no significant differences observed.

**Table 2. Summary of culture positivity rates in the 2 study arms**

<table>
<thead>
<tr>
<th></th>
<th>Double HLD</th>
<th>Single HLD</th>
<th>P value*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All cultures</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specimen-based</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of specimens</td>
<td>3052</td>
<td>2798</td>
<td></td>
</tr>
<tr>
<td>Any growth</td>
<td>127 (4.2)</td>
<td>108 (3.9)</td>
<td>.60 (.64)</td>
</tr>
<tr>
<td>Growth of high-concern pathogens</td>
<td>3 (.1)</td>
<td>5 (.2)</td>
<td>.49 (.43)</td>
</tr>
<tr>
<td>Encounter-based</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of encounters</td>
<td>1526</td>
<td>1399</td>
<td></td>
</tr>
<tr>
<td>Any growth</td>
<td>122 (8.0)</td>
<td>102 (7.3)</td>
<td>.52 (.54)</td>
</tr>
<tr>
<td>Growth of high-concern pathogens</td>
<td>3 (.2)</td>
<td>5 (.4)</td>
<td>.49 (.43)</td>
</tr>
</tbody>
</table>
All 8 high-concern pathogen cultures were recovered from elevator mechanism samples

<table>
<thead>
<tr>
<th>Facility</th>
<th>Culture date</th>
<th>Duodenoscope and linear echoendoscope identification</th>
<th>High-level disinfection method</th>
<th>High-concern pathogen(s) detected</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2/26/2016</td>
<td>1</td>
<td>Single</td>
<td>Enterococcus spp</td>
</tr>
<tr>
<td>A</td>
<td>4/8/2016</td>
<td>2</td>
<td>Double</td>
<td>Enterococcus spp</td>
</tr>
<tr>
<td>A</td>
<td>4/29/2016</td>
<td>2</td>
<td>Single</td>
<td>Enterobacter cloacae</td>
</tr>
<tr>
<td>A</td>
<td>5/6/2016</td>
<td>3</td>
<td>Double</td>
<td>Aeromonas spp</td>
</tr>
<tr>
<td>A</td>
<td>8/8/2016</td>
<td>4</td>
<td>Double</td>
<td><em>Escherichia coli</em> (ESBL+), Enterococcus spp</td>
</tr>
<tr>
<td>B</td>
<td>7/15/2016</td>
<td>5</td>
<td>Single</td>
<td><em>E. coli</em> (ESBL−) and Enterococcus faecalis</td>
</tr>
<tr>
<td>B</td>
<td>7/29/2016</td>
<td>5</td>
<td>Single</td>
<td><em>E. coli</em> (ESBL+) and Enterococcus faecalis</td>
</tr>
<tr>
<td>B</td>
<td>8/1/2016</td>
<td>5</td>
<td>Single</td>
<td>Enterococcus faecium</td>
</tr>
</tbody>
</table>

*ESBL*+, extended spectrum *β*-lactamase; +, positive; −, negative.
Comparison of High-Level Disinfection and Sterilization Procedures

Synder et al. Gastroenterology 2017;153:1018

- Found no significant differences between groups (sHLP, dHLD and HLD/ETO)
- Enhanced disinfection methods did not provide additional protection against contamination
- However
  - Sterilizer used not FDA cleared with SAL10^{-6} for duodenoscopes
  - AER was not indicated for reprocessing duodenoscopes
  - Storage in non-ventilated cabinet per AORN, AAMI/ANSI ST91; SGNA
Multisociety guideline on reprocessing flexible GI endoscopes and accessories

Luke John W. Day, MD, Y. Raman Muthusamy, MD, MAS, James Collins, BS, RN, CNOR, Vladimir M. Kushner, MD, Mandeep S. Sawhney, MD, MS, Nirav C. Thosani, MD, Sachin Wani, MD
In a nonoutbreak setting, repeat HLD has no additional benefit compared with single HLD in reducing bacterial contamination rates for duodenoscopes.
Hospitals performing ERCPs should do one of the following; FDA adopted these recommendations

- Ethylene oxide sterilization after high level disinfection with periodic microbiologic surveillance
- Double high-level disinfection with periodic microbiologic surveillance
- High-level disinfection with scope quarantine until negative culture
- Liquid chemical sterilant processing system using peracetic acid (rinsed with extensively treated potable water) with periodic microbiologic surveillance
- High-level disinfection with periodic microbiologic surveillance
Double HLD versus Liquid Chemical Sterilization for Reprocessing Duodenoscopes
Gromski et al. Gastro Endosc 2021;93:927

No significant difference of positive cultures when comparing double HLD (8) with duodenoscopes undergoing liquid chemical sterilant (9). Most isolates low-concern organisms.

<table>
<thead>
<tr>
<th>Organism</th>
<th>Double high-level disinfection (8 positive cultures)*</th>
<th>Liquid chemical sterilization (9 positive cultures)†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coagulase-negative <em>Staphylococcus</em> spp.</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td><em>Micrococcus</em> spp.</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td><em>Bacillus</em> spp.</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td><em>Streptococcus viridans</em></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td><em>Enterococcus</em> spp.</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><em>Klebsiella pneumoniae</em></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><em>Enterobacter cloacae</em></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

Organisms in bold type are considered high-concern organisms.

*One culture in the double high-level disinfection group had more than 1 organism grow in a positive culture.

†Three cultures in the liquid chemical sterilization group had more than 1 organism grow in a positive culture.
In nonoutbreak setting, limited data suggest that ETO sterilization does not reduce bacterial contamination rates in duodenoscopes compared with single HLD.

The use of ETO sterilization on duodenoscopes during infectious outbreaks has been associated with terminating these outbreaks and such a modality should be considered in selected settings and patient populations.

However, many barriers to widespread use including cost, only 20% hospital use ETO (availability), possible damage to scopes, exposure of staff to ETO, exposure/turnaround time.
Prevent All Infectious Disease Transmission by Medical Devices in 5 years
EH Spaulding believed that how an object will be disinfected depended on the object’s intended use (clarification).

**CRITICAL** - objects which directly or indirectly/secondarily (i.e., via a mucous membrane such as duodenoscope, cystoscope, bronchoscope) enter normally sterile tissue or the vascular system or through which blood flows should be sterile.

**SEMICRITICAL** - objects that touch mucous membranes or skin that is not intact require a disinfection process (high-level disinfection [HLD]) that kills all microorganisms but high numbers of bacterial spores.

**NONCRITICAL** - objects that touch only intact skin require low-level disinfection (or non-germicidal detergent).
Future/Novel Approaches to Endoscope Reprocessing to Improve Patient Safety

Rutala et al. AJIC 2019:47:A62; Chua et al. Techniq Innov Gastro Endo 2021;23:190

- Antimicrobial detergents-reduce microbial contamination
- Automated Endoscope Reprocessing-HLD should be provided in an approved AER (manual-1.4% compliance vs 75.4% using AER)
- Endoscope sterilization-materials compatibility, throughput
- Disposable endoscopes (device innovations)
  - Partially-does it decrease bacterial contamination after HLD
  - Fully-GI and bronchoscopes; cost, scope performance
- Use of non-endoscopic methods to diagnose or treat disease
- Assessment tool that is predictive of microbial contamination or infection risks
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“Given the choice of improving technology or improving human behavior, technology is the better choice”

Robert A. Weinstein, MD
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Terminal Sterilization of Duodenoscopes using HP-Ozone Sterilizer

- Simulated-use and clinical in-use studies demonstrated the efficacy of a HP-ozone sterilizer for terminal sterilization of duodenoscopes
- FDA-cleared for multi-channel flexible endoscopes of up to 3.5 meters
Terminal Sterilization of Duodenoscopes using HP Gas Plasma Sterilizer

• Endoscope (colonoscopes, duodenoscopes) sterilization cycle was developed
• Testing demonstrated the vaporized HP can sterilize flexible GI scopes with a SAL $10^{-6}$
• Not FDA cleared; materials compatibility issues may require changes (e.g., lubricant)
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# Characteristics of Disposable Duodenoscopes

Chua et al. Techniq Innov Gastro Endo 2021;23:190

## Table 2. Characteristics of disposable duodenoscopes.

<table>
<thead>
<tr>
<th></th>
<th>EvisExera III TJF-Q190V (Olympus)</th>
<th>ED34-i10T (Pentax)</th>
<th>ED34-i10T2 (Pentax)</th>
<th>ED-580XT (Fujifilm)</th>
<th>EXALT Model D (Boston Scientific)</th>
<th>aScopeDuodeno (Ambu)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Disposable component</strong></td>
<td>Endcap</td>
<td>Endcap</td>
<td>Endcap</td>
<td>Endcap</td>
<td>Entire endoscope</td>
<td>Entire endoscope</td>
</tr>
<tr>
<td><strong>Field of view (degrees)</strong></td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>108</td>
<td>130</td>
</tr>
<tr>
<td><strong>Depth of view (mm)</strong></td>
<td>5-60</td>
<td>4-60</td>
<td>4-60</td>
<td>4-60</td>
<td>5-60</td>
<td>Not available</td>
</tr>
<tr>
<td><strong>Working length (mm)</strong></td>
<td>1240</td>
<td>1250</td>
<td>1250</td>
<td>1250</td>
<td>1240</td>
<td>1240</td>
</tr>
<tr>
<td><strong>Instrument channel (mm)</strong></td>
<td>4.2</td>
<td>4.2</td>
<td>4.2</td>
<td>4.2</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td><strong>Insertion tube diameter (mm)</strong></td>
<td>11.3</td>
<td>11.6</td>
<td>11.6</td>
<td>11.3</td>
<td>11.3</td>
<td>11.3</td>
</tr>
<tr>
<td><strong>Distal end diameter (mm)</strong></td>
<td>13.5</td>
<td>13</td>
<td>13</td>
<td>13.1</td>
<td>15.1</td>
<td>13.7</td>
</tr>
<tr>
<td><strong>Distal end with endcap (mm)</strong></td>
<td>13.5</td>
<td>13.8</td>
<td>13.4</td>
<td>14.9</td>
<td>15.1</td>
<td>13.7</td>
</tr>
</tbody>
</table>
Future/Novel Approaches to Endoscope Reprocessing to Improve Patient Safety
Rutala et al. AJIC 2019:47:A62; Chua et al. Techniq Innov Gastro Endo 2021;23:190

• Antimicrobial detergents

• Automated Endoscope Reprocessing-HLD should be provided in an approved AER (manual-1.4% compliance vs 75.4% using AER)

• Endoscope sterilization-materials compatibility, throughput

• Disposable endoscopes (device innovations)
  • Partially—does it decrease bacterial contamination after HLD
  • Fully—GI and bronchoscopes; cost, scope performance

• Use of non-endoscopic methods to diagnose or treat disease

• Assessment tool that is predictive of microbial contamination or infection risks
Implementing these advances will allow us to prevent endoscopy-related infections.
Thank you!

www.disinfectionandsterilization.org