Endoscopy in the 21st century: minimally invasive state of the art medical technology or a future main vector of hospital-acquired infections?

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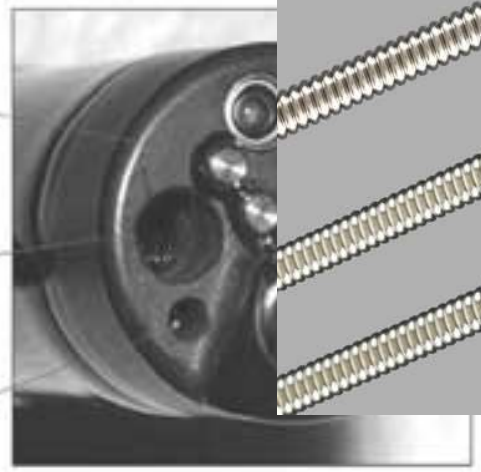
Looking inside patients

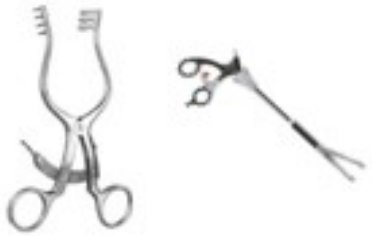
2016

Looking inside patients



23RD WORLD STERILIZATION CONGRESS

Spaulding classification

Patient Contact	Examples	Device Classification	Minimum Inactivation Level
Intact skin		Non-Critical	Cleaning and/or Low/Intermediate Level Disinfection
Mucous membranes or non-intact skin		Semi-Critical	"High Level Disinfection"
Sterile areas of the body, including blood contact		Critical	Sterilization

UK recommendations after vCJD

Department of Health

Health Technical Memorandum 01-06: Decontamination of flexible endoscopes

Part A: Policy and management

March 2016

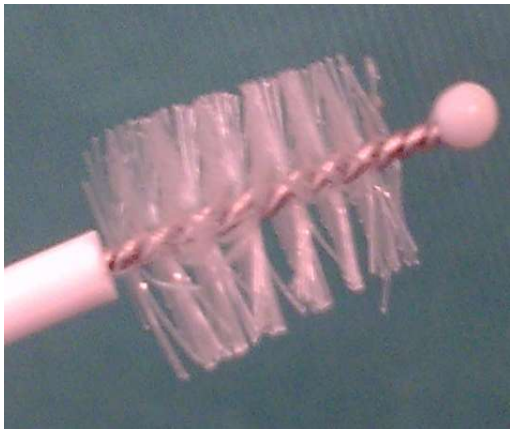
Endoscopes that enter sterile body tissues:
Manual cleaning, automated cleaning and disinfection; rinse-water with limited bacterial contamination, followed by sterilization. (Guidance on these endoscopes is not included in this HTM.)

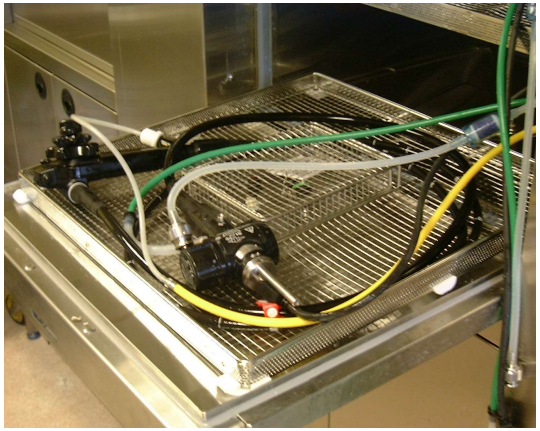
Endoscopes that enter sterile body cavities via contaminated body cavities:
Manual cleaning, automated cleaning and disinfection; rinse-water with very low bacterial contamination

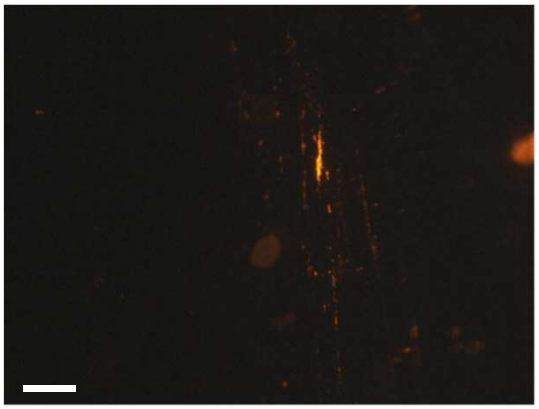
Endoscopes that enter contaminated body cavities:
Manual cleaning, automated cleaning and disinfection; rinse-water with limited bacterial contamination

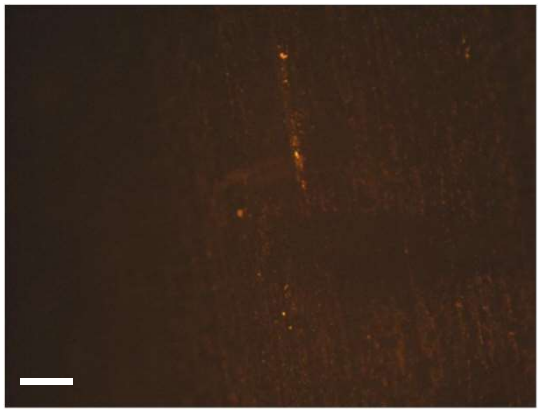
Endoscopes without lumens:
Manual cleaning and manual disinfection as EQR and use of manual cleaning followed by an endoscope washer-disinfector (EWD) as possible Best Practice

Standard reprocessing of flexible luminal endoscopes









Hervé *et al*., JHI 2012

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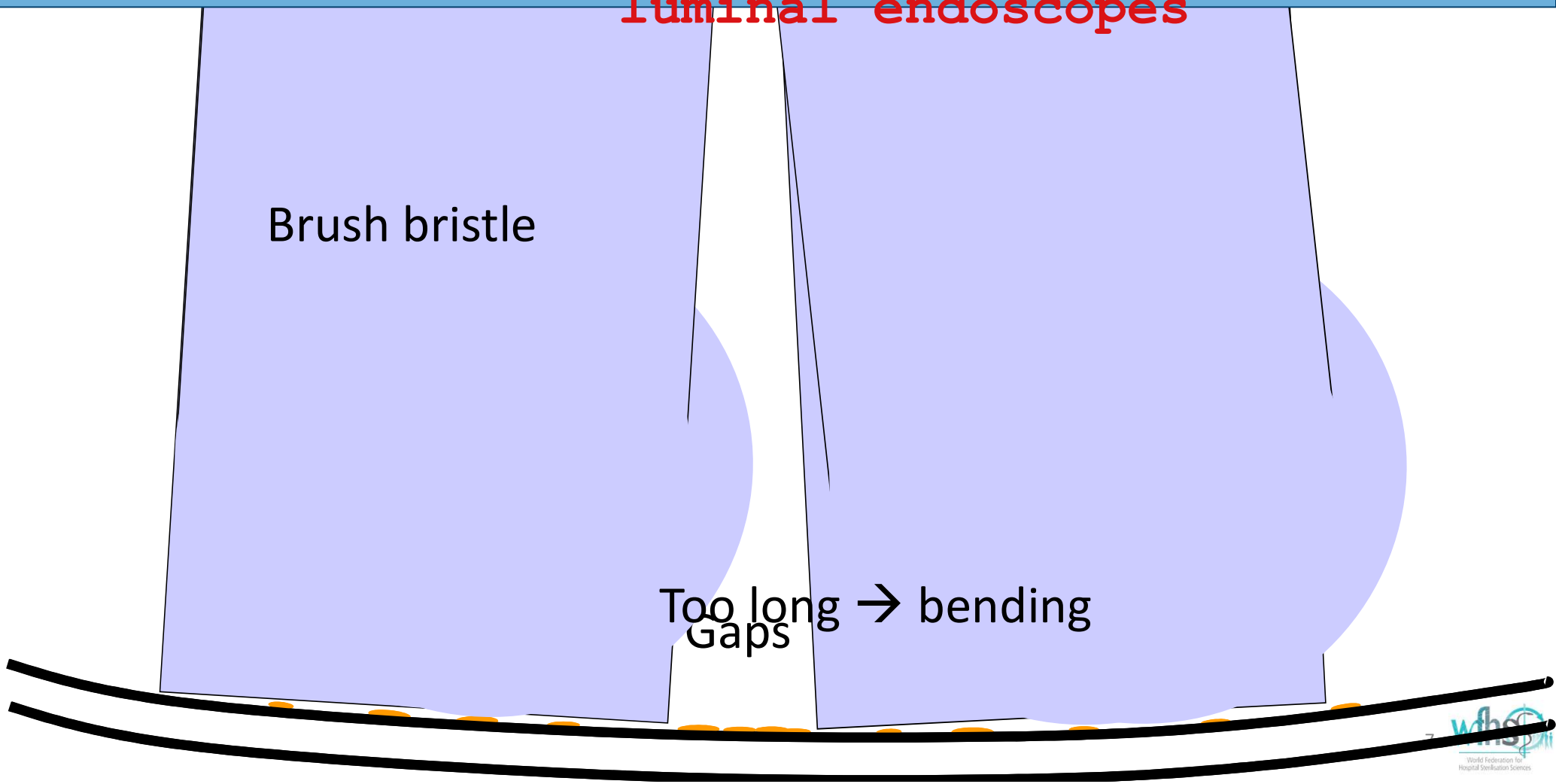

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Endoscopic Retrograde Cholangio-Pancreatography

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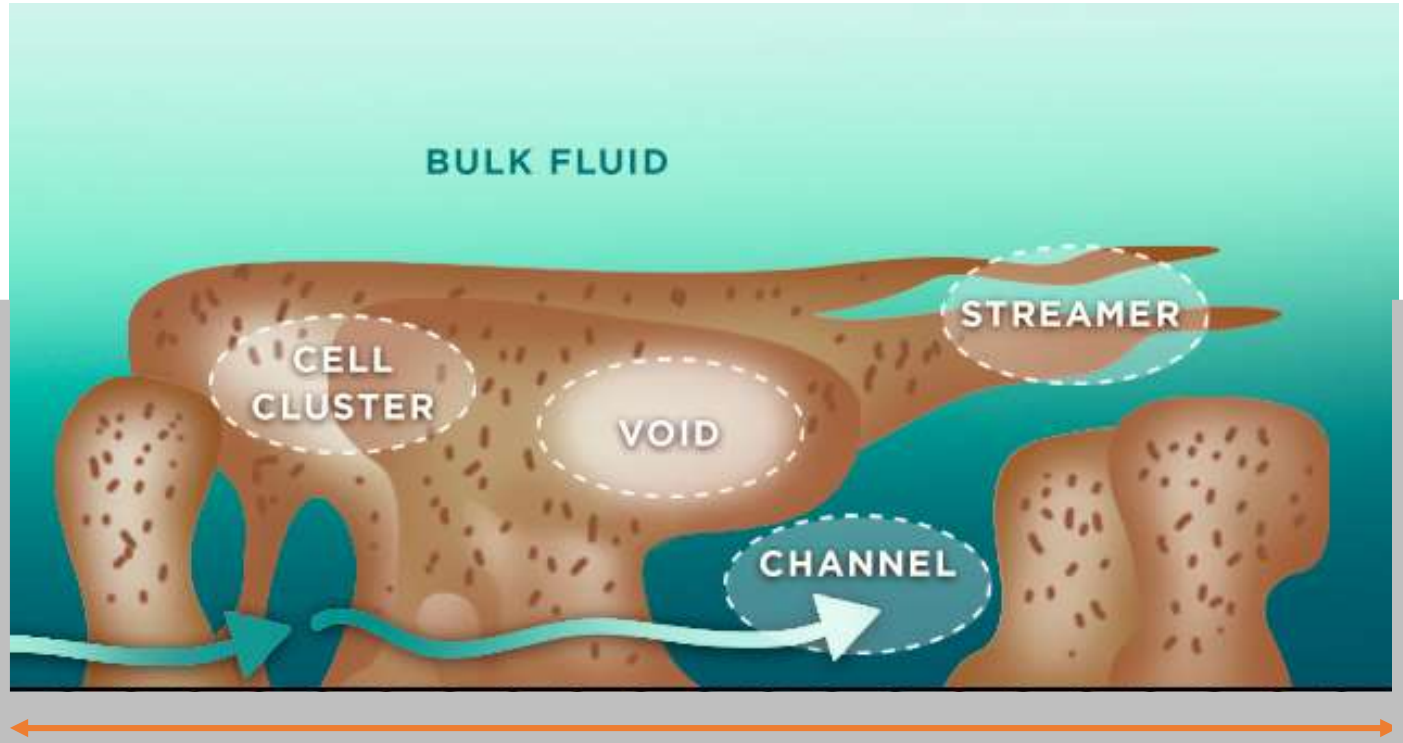
Biofilms are 3D structures



E.g. 0.1mm

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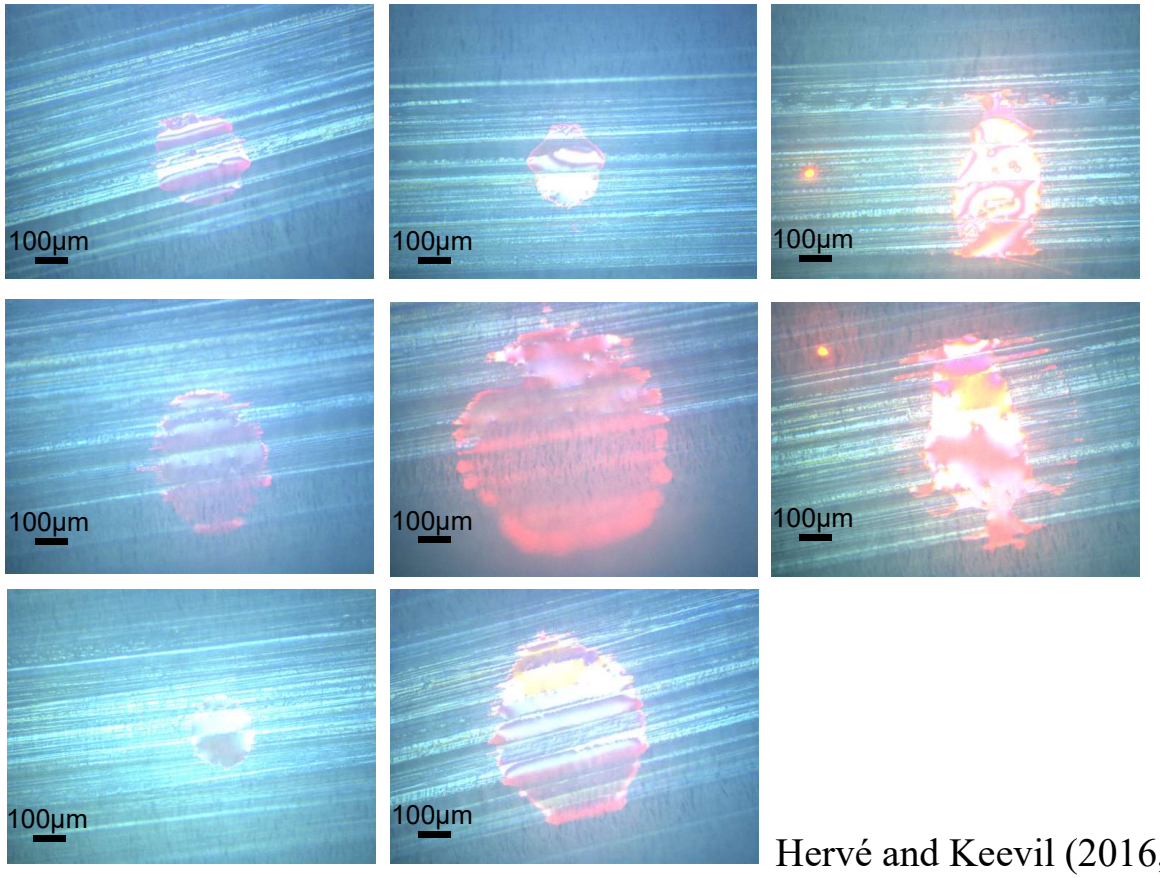
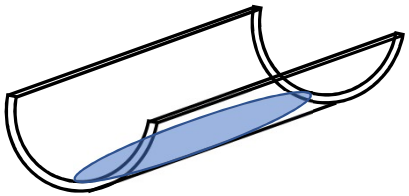
Channels recovered from endoscopes in clinical use





Hervé and Keevil (2016, Endoscopy)

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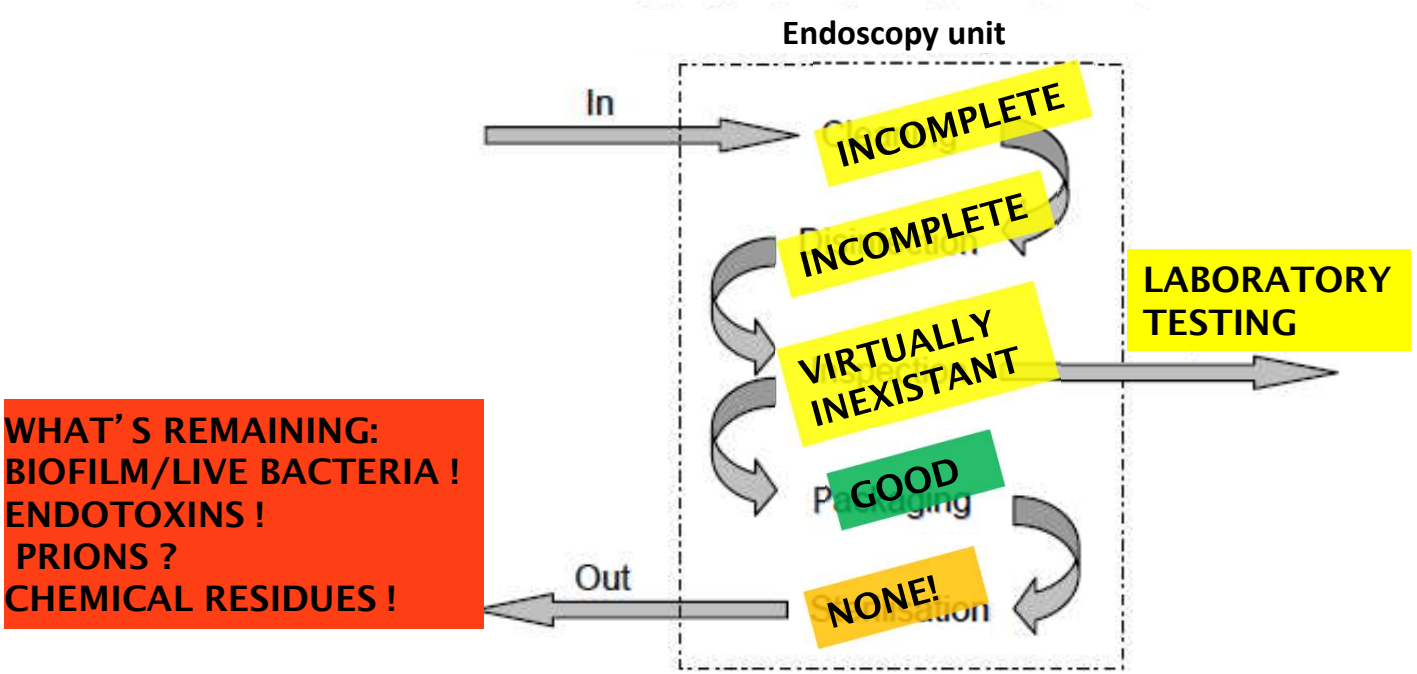
So what does this mean?



The five main functions performed in a hospital sterile service department

...and where it can fail.

Standard reprocessing of flexible luminal endoscopes

Cleaning limitations: biofilm growth

American Journal of Infection Control 44 (2016) e221-e226

Contents lists available at ScienceDirect

Persistent residual contamination in endoscope channels; a fluorescence epimicroscopy study

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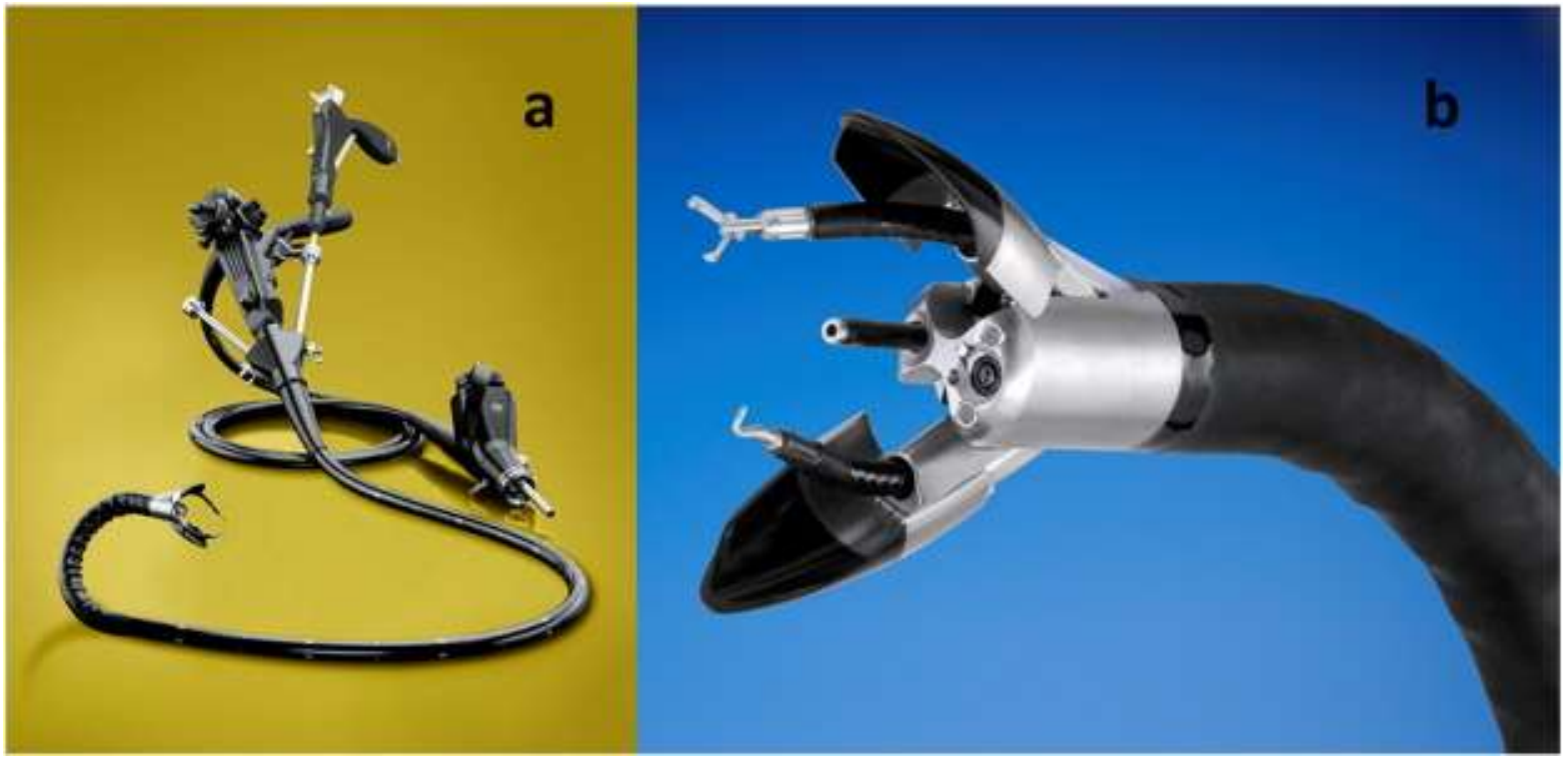
How simpler and easier may it become?



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Infection control in the SSD/endoscopy unit

Steps in infection control	Tools available
Locate (and identify) the infectious agent(s)	Eyes, detection kits, bioassays
Eliminate (or neutralize?) the infectious agent(s)	Equipment (AERs) and chemicals
Prevent introducing new infectious agent(s)	SOPs (based on RA)

Standard reprocessing of flexible luminal endoscopes

How can standard reprocessing fail ?

Mechanism	Potential caveats
Physical disruption (detergent, sonication, brushing, flushing)	Displacement and/or spreading, blockages, damage
Enzymatic degradation	Shelf life; control of parameters
Chemical modification (pH>12…not 1/1000!) E.g. hypochlorite 10k ppm	Damage to instruments; control of parameters and efficacy

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So what can we do?

- Improve (develop!) surveillance of instruments

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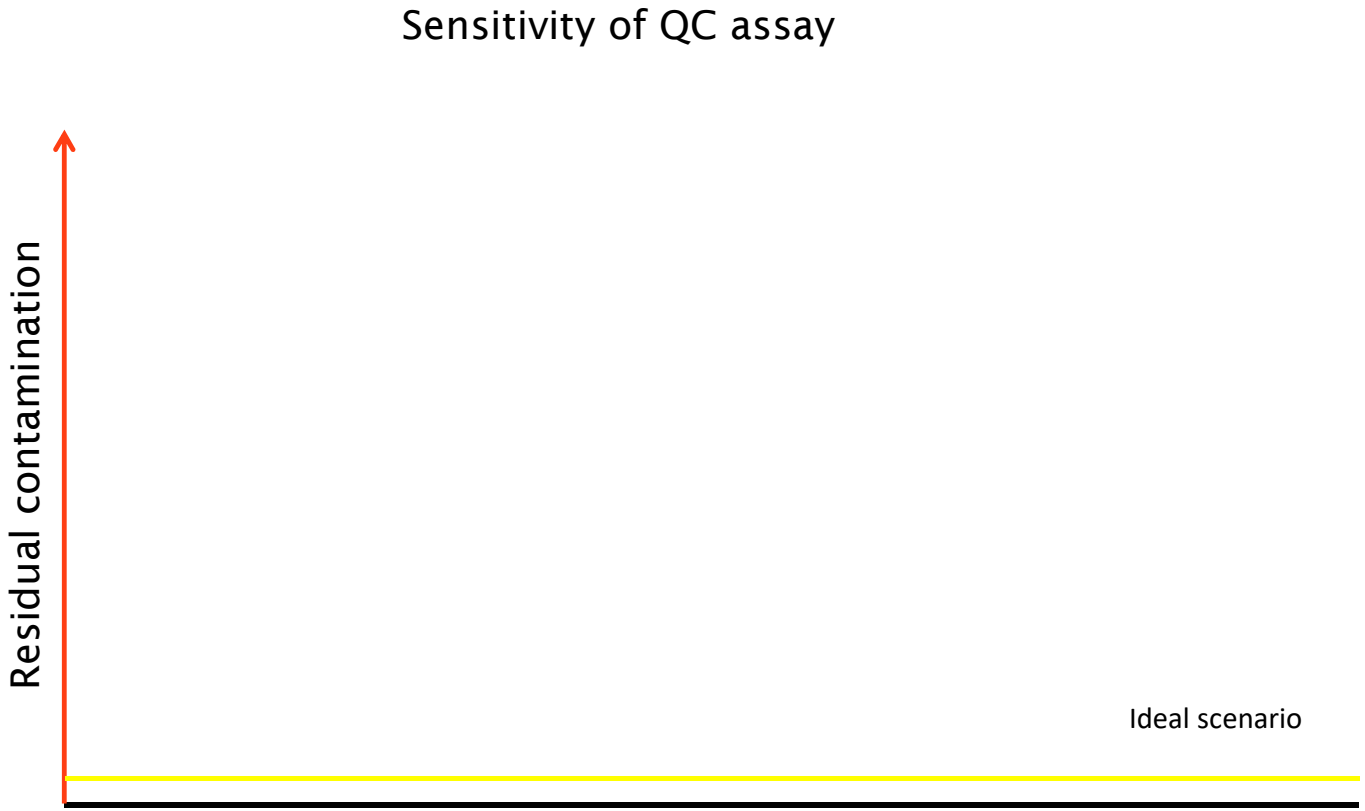
How clean is clean?



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Episcopic Differencial Interference Contrast with Epifluorescence (EDIC/EF) microscopy.

Limit of detection well beyond necessary and practical values (over 2-log more sensitive than WB).

Total proteins (SYPRO Ruby)
MLD_{75} = 175 pg/mm^2 (95% CI 104 – 286 pg/mm^2)
~ 5 femtomoles

Amyloid proteins (Thioflavin T)
Prp^{Sc} – 1 μm / 1pg aggregates
~ 30 attomoles

ThT (amyloid) and SR (all proteins) non toxic at concentrations bound to contaminated surfaces.

Live/dead or other staining of individual bacteria within biofilms.

Keevil *et al*., Water Sci Technol 2003
Lipscomb *et al*., JHI 2006

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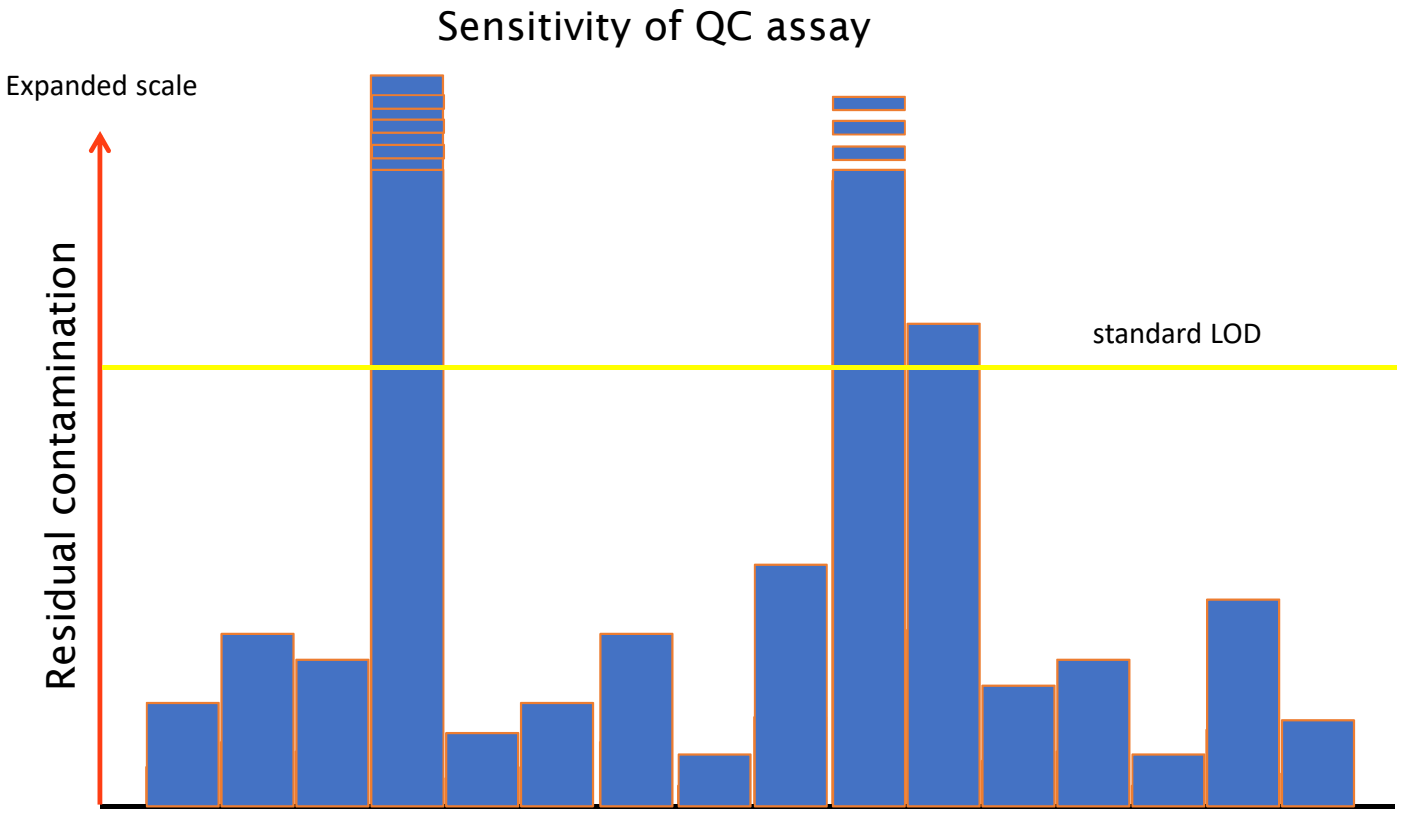
How clean is clean?



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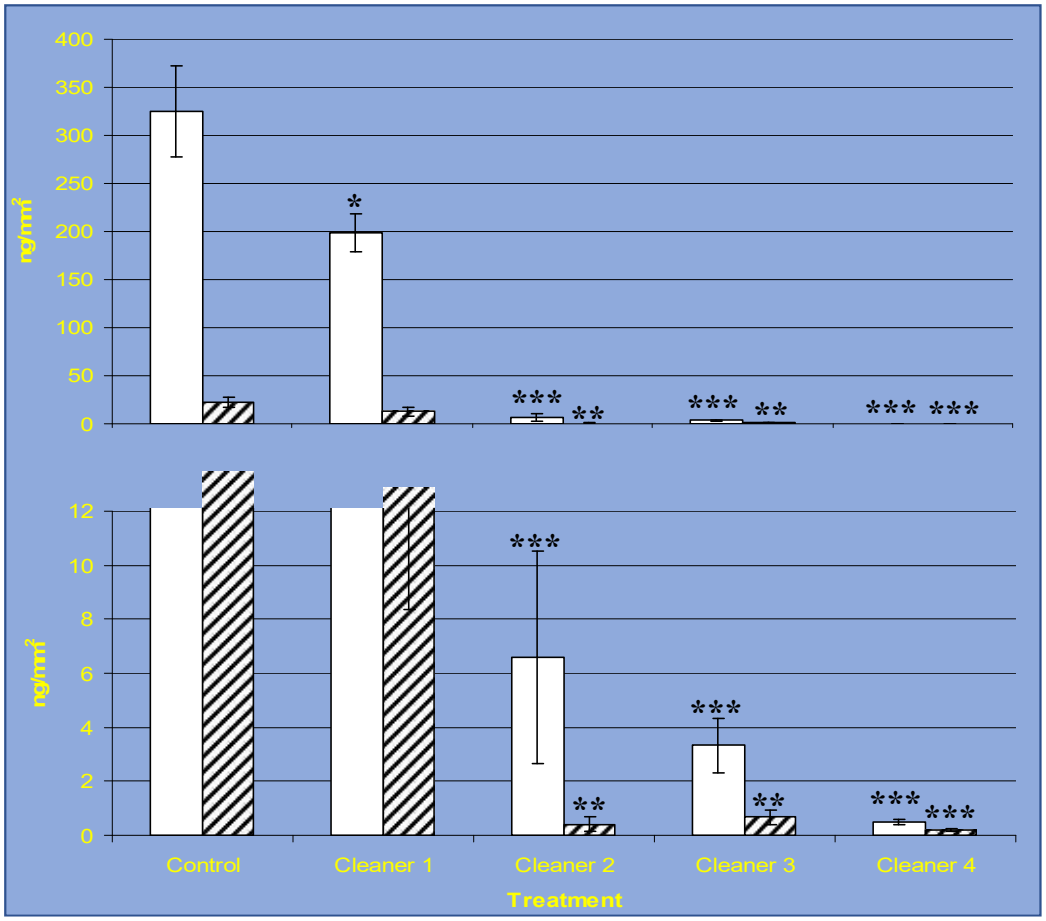
Cleaning limitations: Protein removal action of various cleaners



Hervé *et al.*, JHI 2010

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So what can we do?

- Improve (develop!) surveillance of instruments
- Improve reprocessing efficacy and/or prevent biofilms

Standard reprocessing of flexible luminal endoscopes

Targeting residual contamination in long lumen

1. Water-based treatments:

Pros: a) Homogeneity of the mixture

b) Even distribution throughout whole channel

Cons: a) High volume of waste

b) Inefficient against adsorbed/incrusted microcontamination

c) Requires rinse; chemical residues?

d) Additional treatments (e.g. ethylene oxide…)

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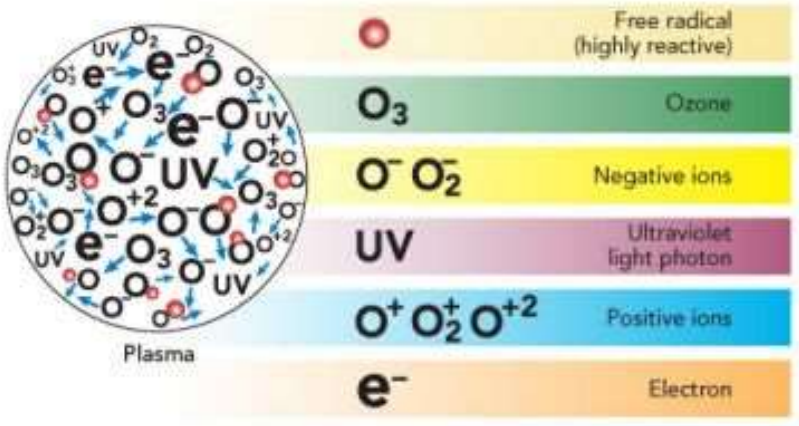
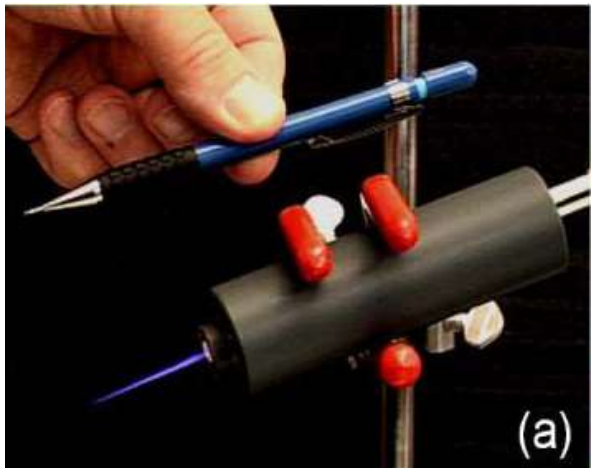
Gas plasma for endoscope reprocessing





Non-equilibrium Chemistry

Benefits

- Energetic electrons → chemical dissociation @ low gas temperature

- On-site production of reactive, short-living species e.g. $O_2^{\bullet -}$; O; $^1O_2$; NO … $OH^\bullet$ and H_2O_2 → known to act on protein, lipid and DNA

- **Oxidants**: $OH^\bullet$, $O_2^{\bullet -}$; O; $^1O_2$, H_2O_2

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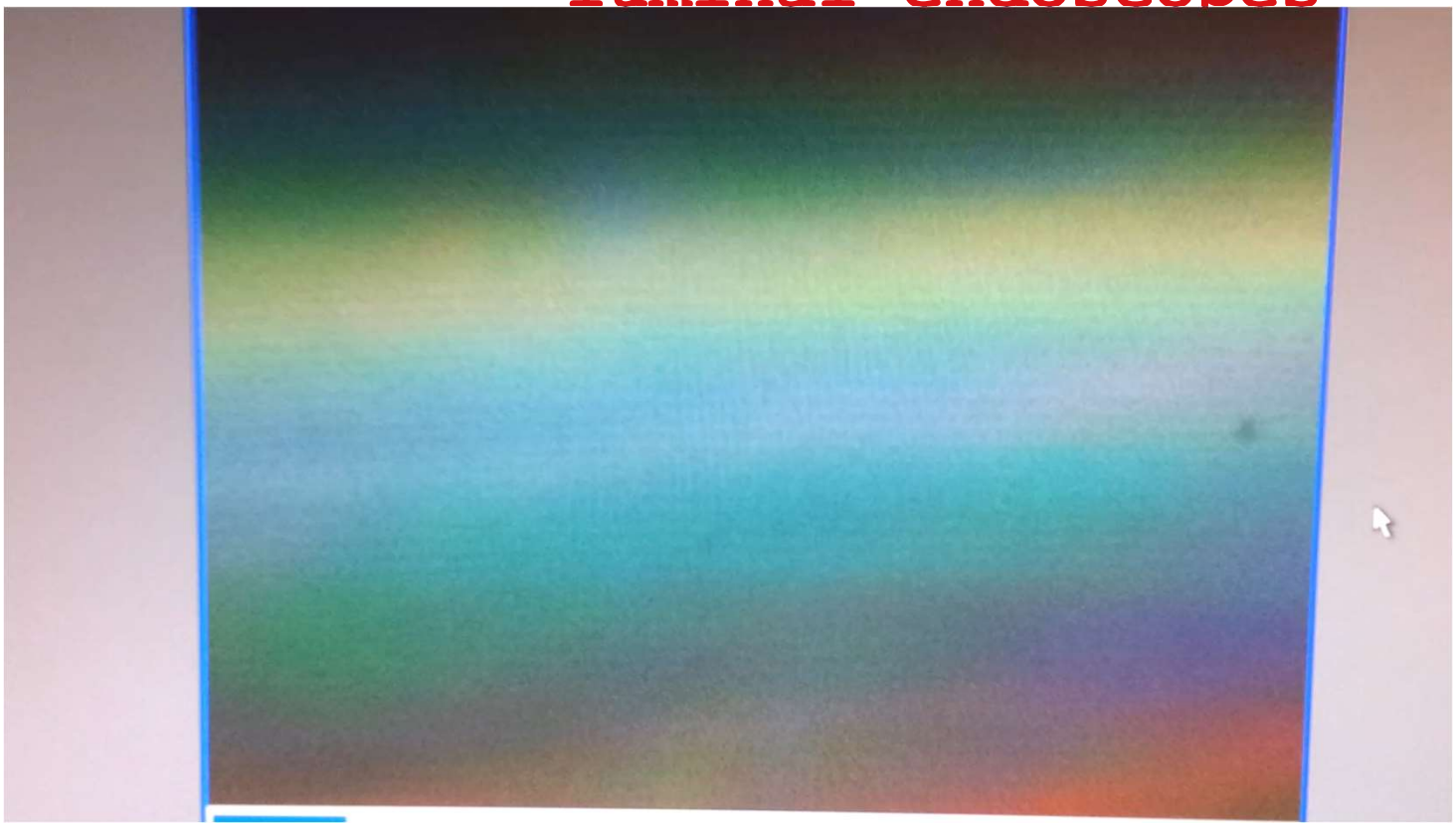

Standard reprocessing of flexible luminal endoscopes

Targeting residual contamination in long lumen

1. Plasma-based treatment:

Pros: a) Very efficient against bacteria* (prions?)

b) No extra volume of waste generated

c) No potentially harmful residues

Cons: a) Uneven distribution and short life span, hence possibly reduced effective range (effect of PAG*)

b) Non-homogenous mix

*: Bhatt *et al.*, GIE journal 2018

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Infection control in the SSD/endoscopy unit

Steps in infection control	Tools available
Locate (and identify) the infectious agent(s)	Simple, cheap and rapid surveillance tools
Eliminate (or neutralize?) the infectious agent(s)	More effective, yet still affordable decontamination technologies
Prevent introducing new infectious agent(s)	Increase in AMR, pressures on healthcare

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Infection control in the future endoscopy units…

Ever increasing demand	Costs
Providing the service (prevention better than cure)	Liability
Single use devices	Costs
Better cleaning technologies?	Costs
Patients safety (“first do no harm”)	AMR

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Conclusions

Proteinaceous and microbial contamination are common problems in clinical settings worldwide.

Current standard decontamination procedures suffer from inherent physicochemical limitations.

Current standard surveillance procedures suffer from poor accessibility (particularly for luminal flexible endoscopes) and limited recovery; current tolerance margins only reveal the “tip of the iceberg”.

Further development of emerging decontamination and surveillance technologies are required (at a cost) to match the increase in instruments complexity and usage.

Standard reprocessing of flexible luminal endoscopes

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