Universiteit Antwerpen
Faculteit Farmaceutische, Biomedische en Diergeneeskundige Wetenschappen

Endocavitary probes

A comparative study between two high level disinfection techniques

Apr. Caroline Danen

AZ Klina
voluit voor zorg

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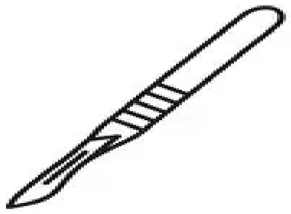
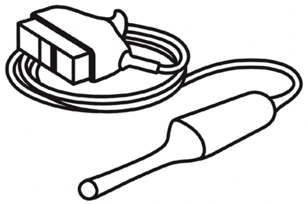
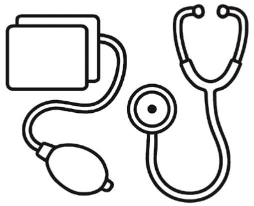
Endocavitary probes

- Ultrasonography
- Advantages
  - Safety
  - Ease of use
  - Real-time imaging
- Rising prevalence multi-drug resistant MO
- Transmission vector
  - Ex. HPV, HIV, VRE, ..

Spaulding classification

Category	Definition	Necessary level	Example
Critical	Instruments that enter sterile tissue or the bloodstream.	**Sterilization**	
Semi-critical	Equipment/devices that contact mucous membranes or non-intact skin but do not penetrate them	**High level disinfection**	
Non-critical	Equipment/device that touches intact skin only.	**Low level disinfection**	

Guidelines

1. No unanimity
2. High level disinfection
3. Which method is the best?
4. Important to analyse existing HLD methods
5. Need for a specific disinfection guideline

- Probe cover
- The first step = cleaning
- HLD preferable automatic
- Disinfection of the handle

5.4.1 Behandeling van rigide echografiesondes met mantel

De behandeling betreft rigide endovaginale en endorectale echografiesondes. Het gebruik van een beschermende mantel voor deze sondes is verplicht. Tussen twee onderzoeken is een *high level* desinfectie vereist. Na het verwijderen van de beschermende mantel moet de sonde worden afgeveegd met een droog en schoon doekje.

Het wassen en de *high level* desinfectie zijn **VERPLICHT.**

Het wassen gebeurt via manuele reiniging met
- een reinigingsoplossing (onderdompeling) of
- een doekje of een kompres dat gedrenkt is in een geschikt reinigingsmiddel (hoofdstuk 6) of
- een gebruiksklaar doekje.

De *high level desinfectie* gebeurt
- bij voorkeur via geautomatiseerde systemen voor *high level* desinfectie(punt 5.5.1.)
- door onderdompeling of door het aanbrengen van een *high level* desinfecterende oplossing met behulp van doekjes (ACIPC, 2017 ; Hajjar 2010 ; Rutala & Weber, 2016 ; SFERD, 2016).

Men mag niet vergeten om, behalve de echografiesonde zelf, ook het handvat te desinfecteren.

Causes of present contamination

Probe cover

Turnover time

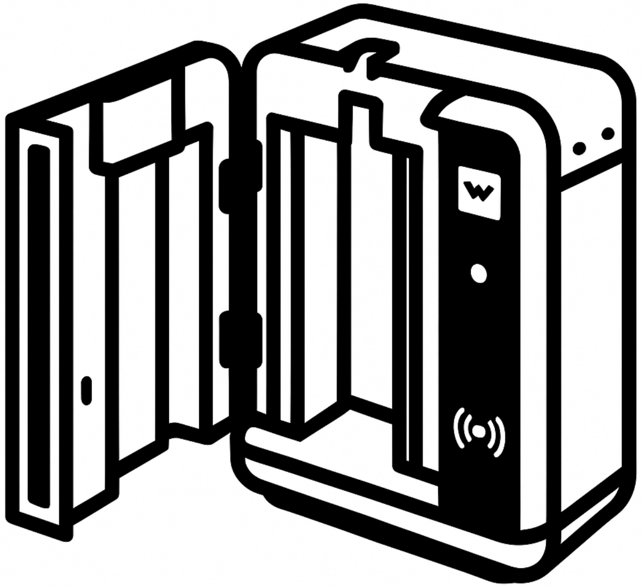
No visible contamination, no disinfection

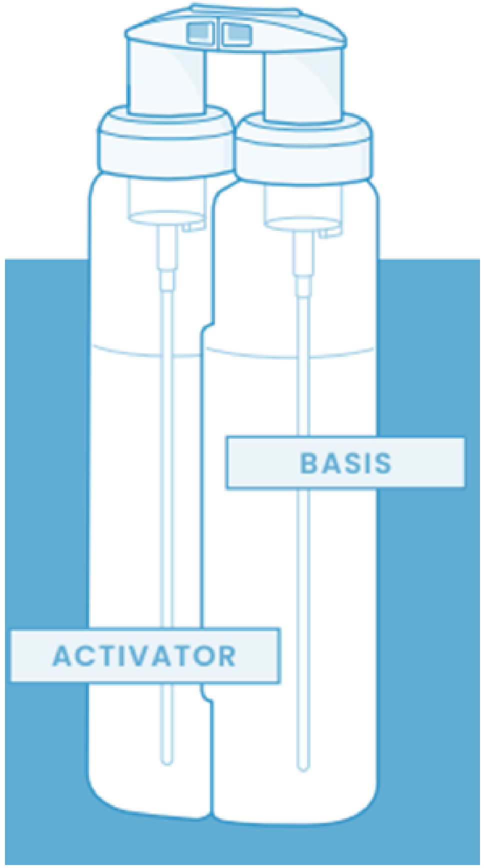
Education

High level disinfection methods

Chlorine dioxide foam (Tristel Duo ULT)

UV-C radiation (UV Smart D45)

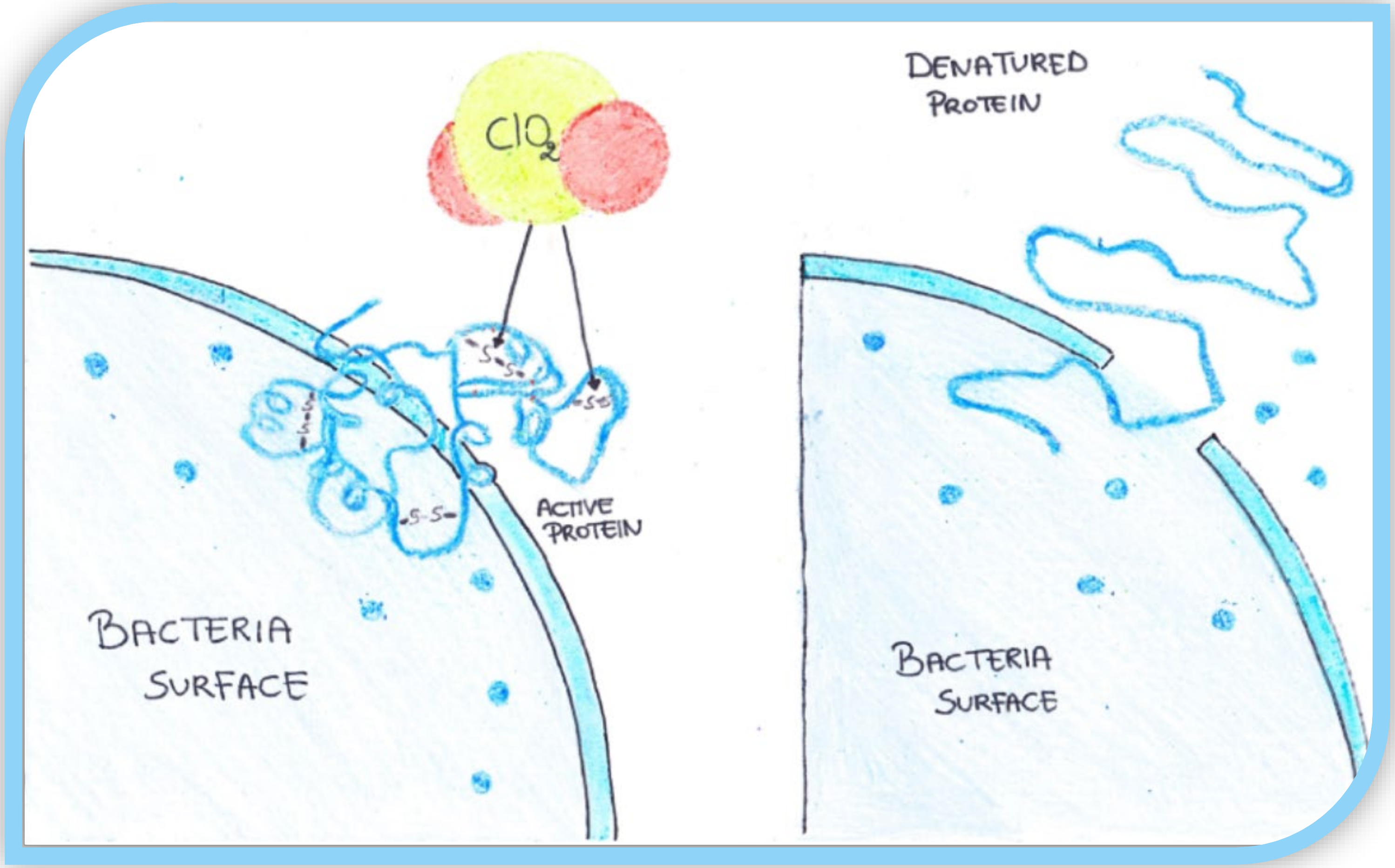




Chemical mechanism

- Reaction between citric acid and sodium chlorite
  - Results in formation of chlorine dioxide (ClO_2)
- ClO_2 will act as an antioxidant
  - Electrons will be extracted from micro-organisms (MO), resulting in their death
- Resistance cannot arise

Chlorine dioxide foam



Chlorine dioxide foam: Tristel Duo ULT

Tristel Duo ULT

SAMENVATTING MICROBIOLOGISCHE WERKZAAMHEID

Een uniforme contacttijd van 30 sec voor ALLE biocide claims

Testen uitgevoerd in overeenstemming met de Europese Norm EN 14885:2022 en de meest recente wettelijke werkzaamheidsvereisten voor desinfectiemiddelen in de medische sector.

ORGANISME	TESTMETHODE	TESTTYPE	CONDITIES
SPORICIDE			
Bacillus subtilis	EN 17126	Suspensie	Schoon 1 & Vuil 1
Bacillus cereus			
Clostridioides difficile			
MYCOBACTERICIDE/TUBERCULOCIDE			
Mycobacterium terrae	EN 14348	Suspensie	Schoon 1 & Vuil 1
Mycobacterium avium			
VIRUCIDE			
Poliovirus Type 1	EN 14476	Suspensie	Schoon 1 & Vuil 1
Adenovirus Type 5			
Murine Norovirus			
FUNGICIDE/YEASTICIDE			
Candida albicans	EN 16615	Oppervlaktetest met mechanische actie	Schoon 1 & Vuil 1
Aspergillus brasiliensis	EN 13624	Suspensie	Schoon 1 & Vuil 1
Candida albicans			
BACTERICIDE			
Staphylococcus aureus	EN 16615	Oppervlaktetest met mechanische actie	Schoon 1 & Vuil 1
Enterococcus hirae			
Pseudomonas aeruginosa			
Staphylococcus aureus	EN 13727	Suspensie	Schoon 1 & Vuil 1
Enterococcus hirae			
Pseudomonas aeruginosa			

Tristel Duo ULT

SAMENVATTING MICROBIOLOGISCHE WERKZAAMHEID

Een uniforme contacttijd van 30 sec voor ALLE biocide claims

Bijkomende testen

ORGANISME	TESTMETHODE	TESTTYPE	CONDITIES
VIRUSSEN			
Bovine Coronavirus	EN 16615	Oppervlaktetest met mechanische actie	Vuil 1
Murine Norovirus			Schoon 1 & Vuil 1
Adenovirus Type 5			Vuil 1
Humaan papillomavirus (HPV) Type 16	Meyers et al (J Med Virol. 2020; 92: 1298–1302.)	Gesimuleerd-gebruik test	Vuil 2
Humaan papillomavirus (HPV) Type 18			
Poliovirus Type 1	ASTM E-1053	Oppervlaktetest zonder mechanische actie	Vuil 2
Adenovirus Type 5			
Feline Calicivirus			
Hepatitis-B virus (HBV)			
Herpes-simplexvirus (HSV) Type 1			
Humaan Immunodeficiëntievirus (HIV)			
Influenza A-virus (H1N1)			
Parvovirus (Minute Virus of Mice (MVM) gebruikt als substituut)	DVV/RKI	Suspensie	Vuil 3
Poliovirus Type 1			Schoon 2 & Vuil 3
Adenovirus Type 5			
Murine Norovirus			
Humaan papillomavirus (HPV) (Polyomavirus SV40 gebruikt als substituut)			
Vaccinia Virus			
Influenza A-virus (H1N1)	EN 14476	Suspensie	Vuil 1

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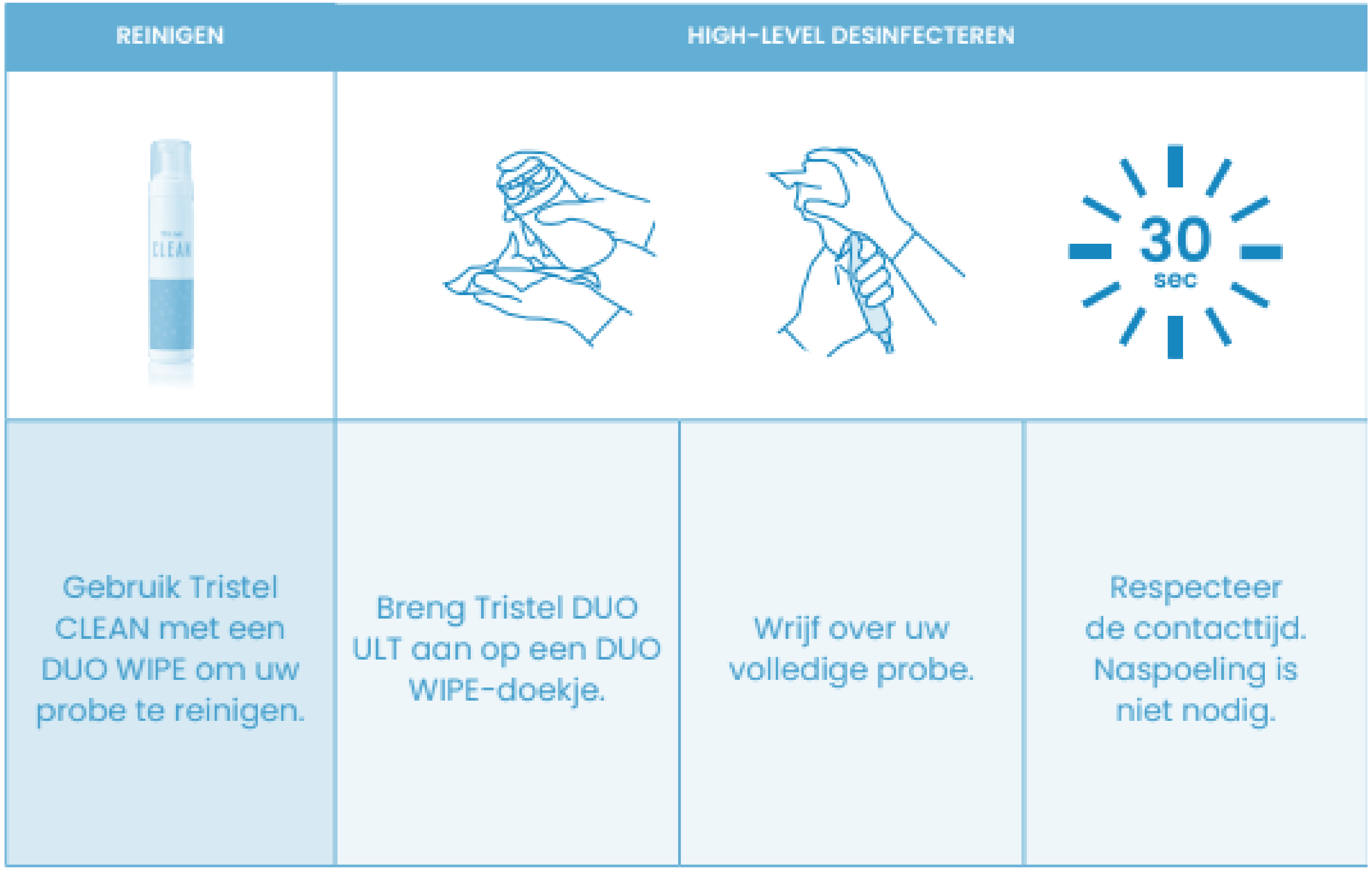
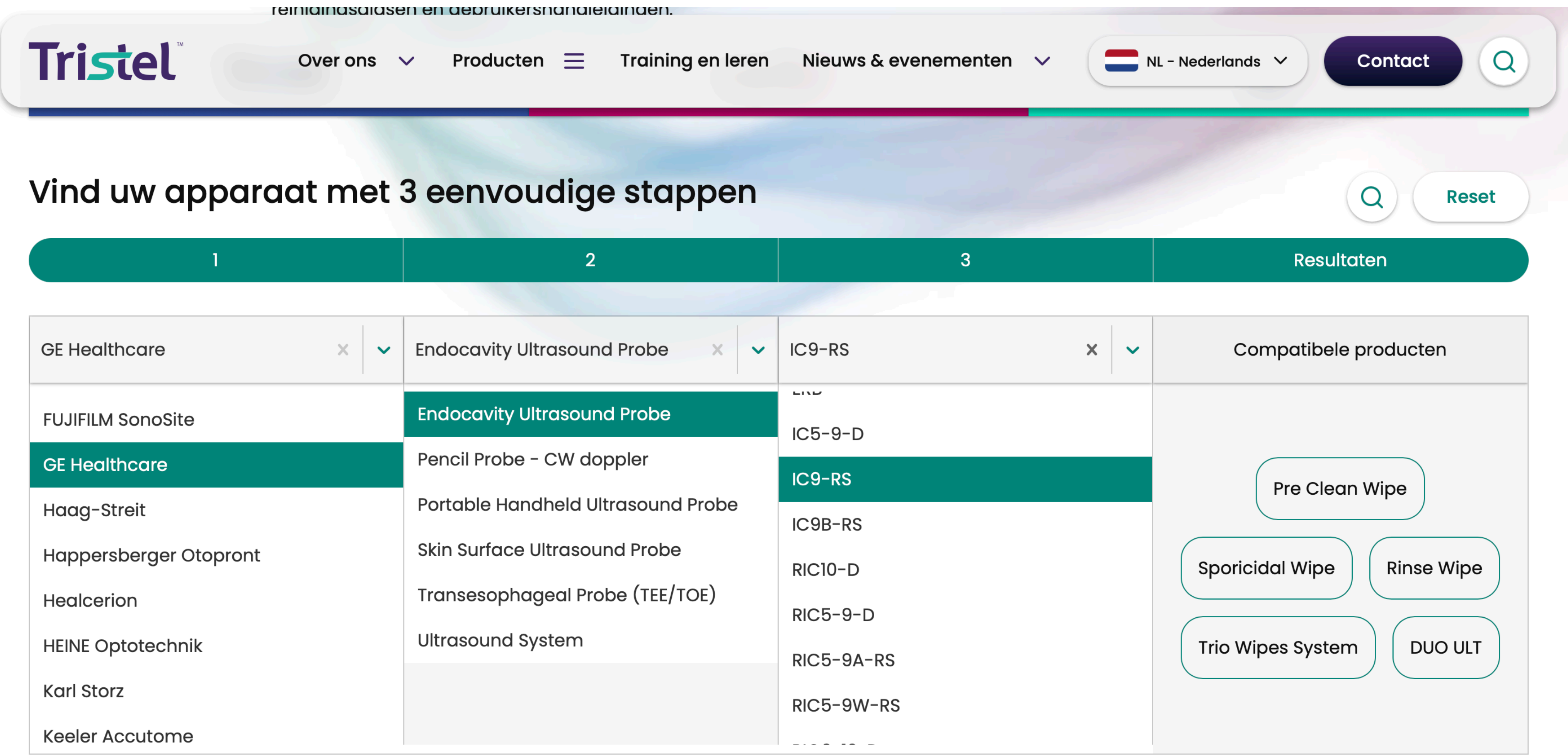
Chlorine dioxide foam: Tristel Duo ULT

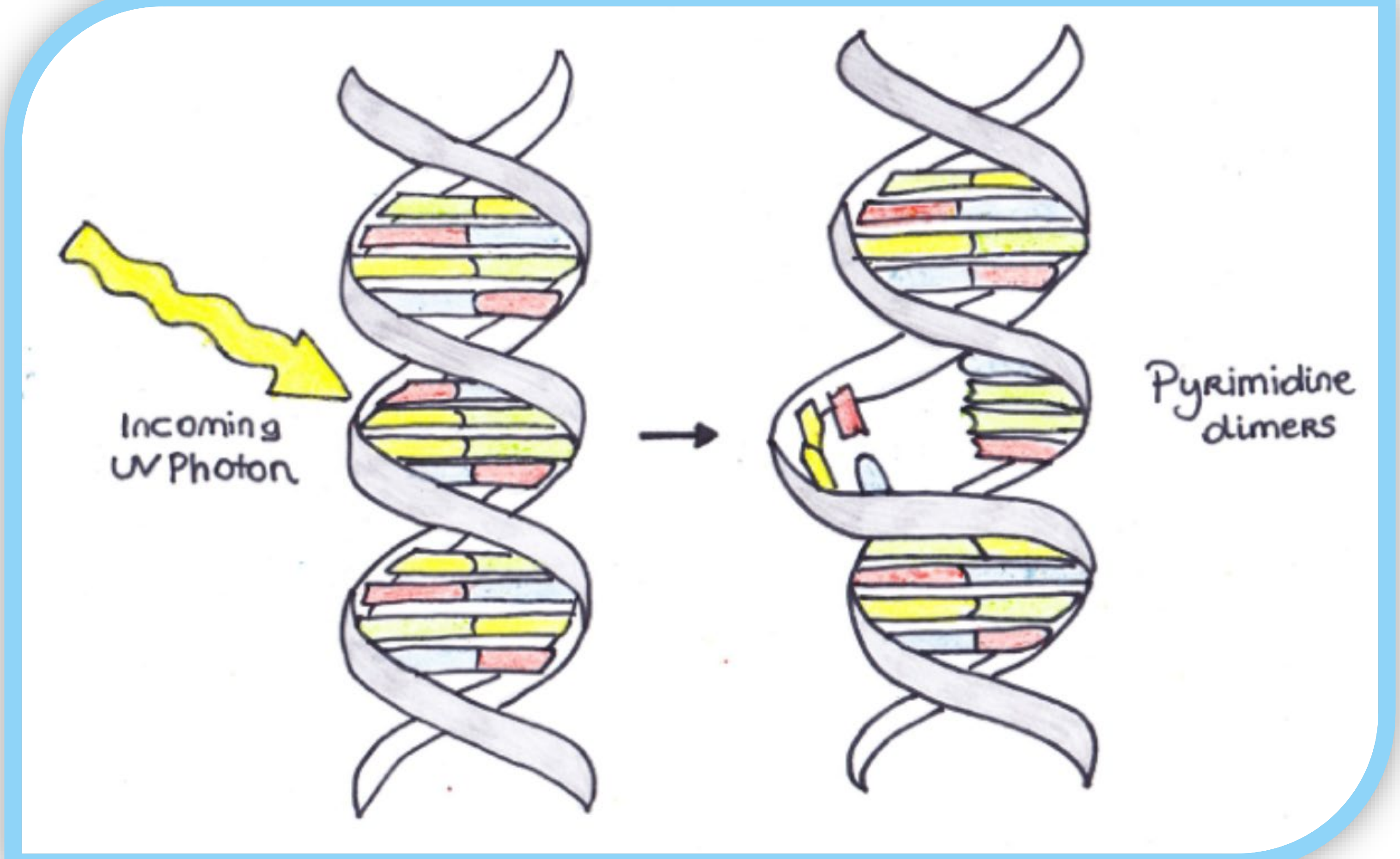
- **How to use:**



Chlorine dioxide foam: Tristel Duo ULT

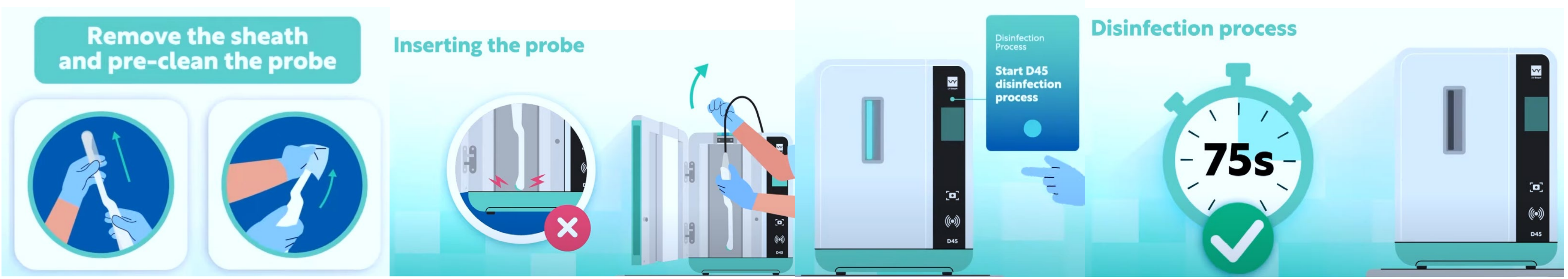


Ultraviolet C radiation

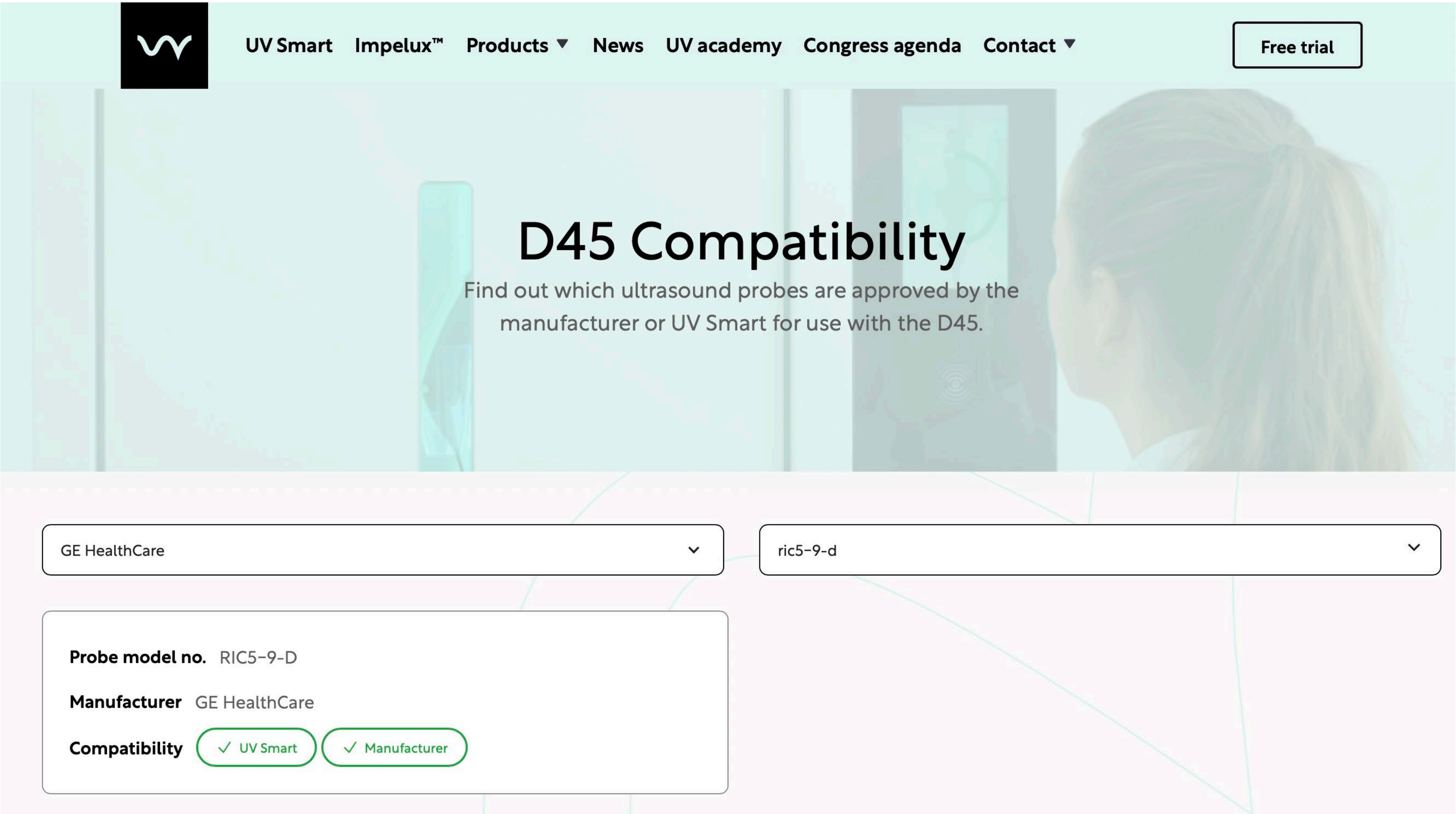


Ultraviolet-C radiation

- Broad spectrum
- Online compatibility tool
- Traceability with scanning
- How to use:



Ultraviolet-C radiation



Study settings

AZ Klina, Gynecology department

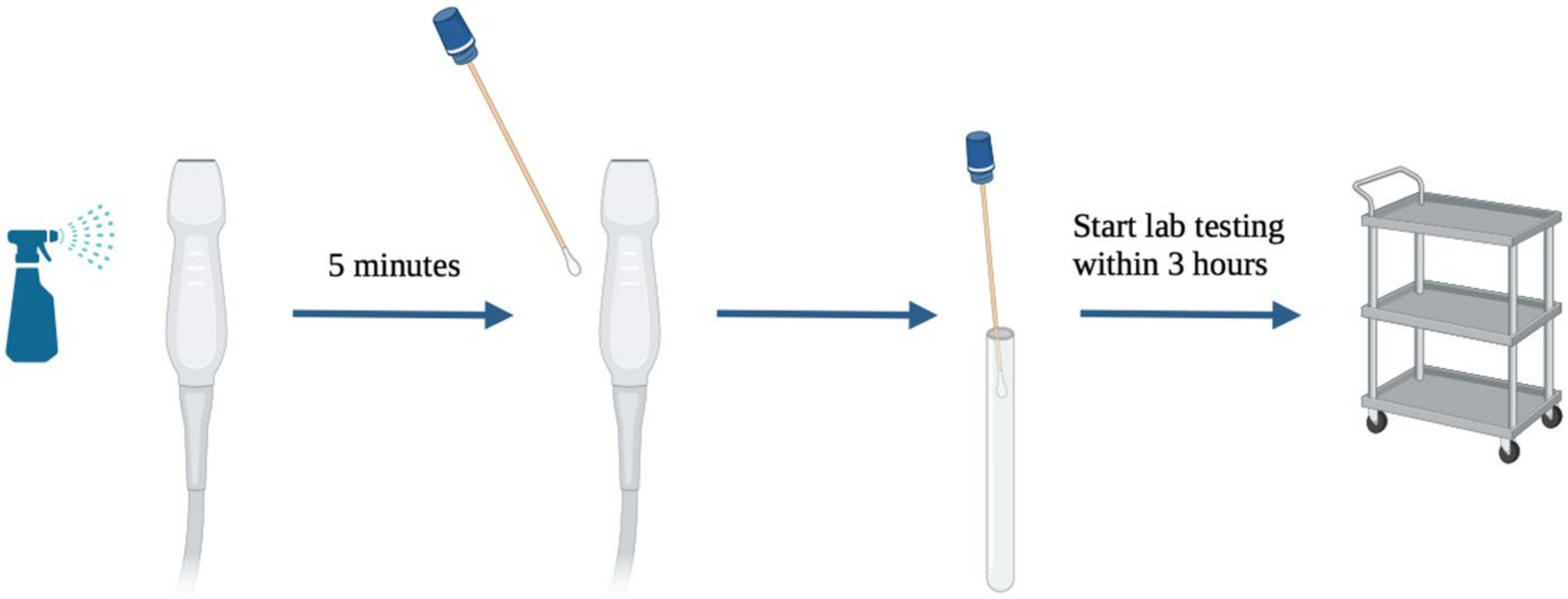
July – September 2024

4 endocavitary probes

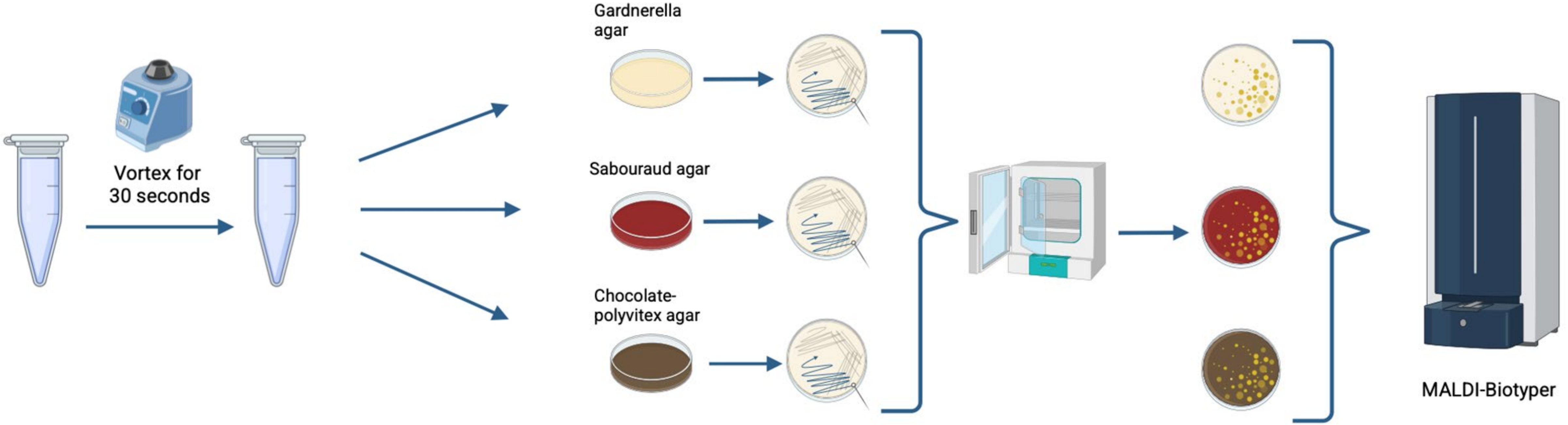
GE RIC5-9-D

GE IC9-RS

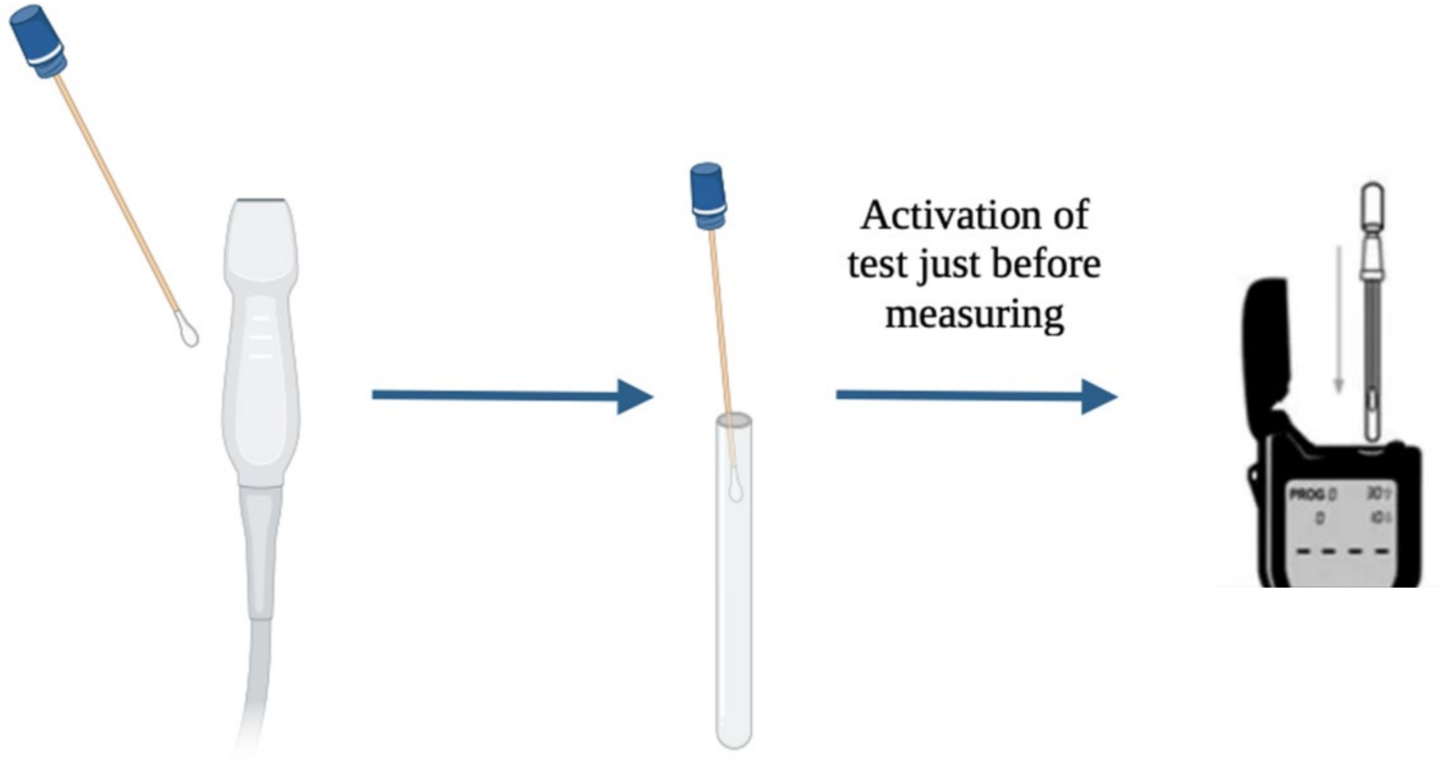
Sample collection



Sample processing

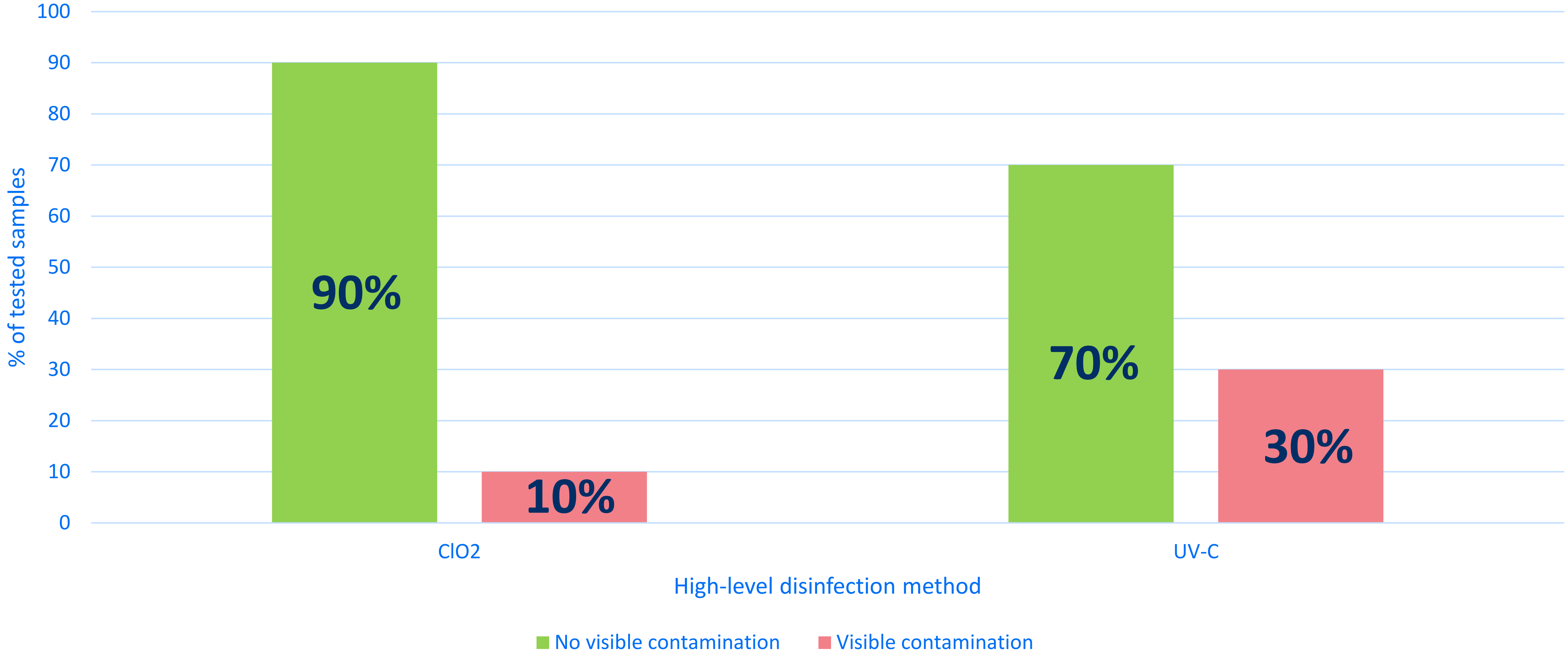


ATP measurements

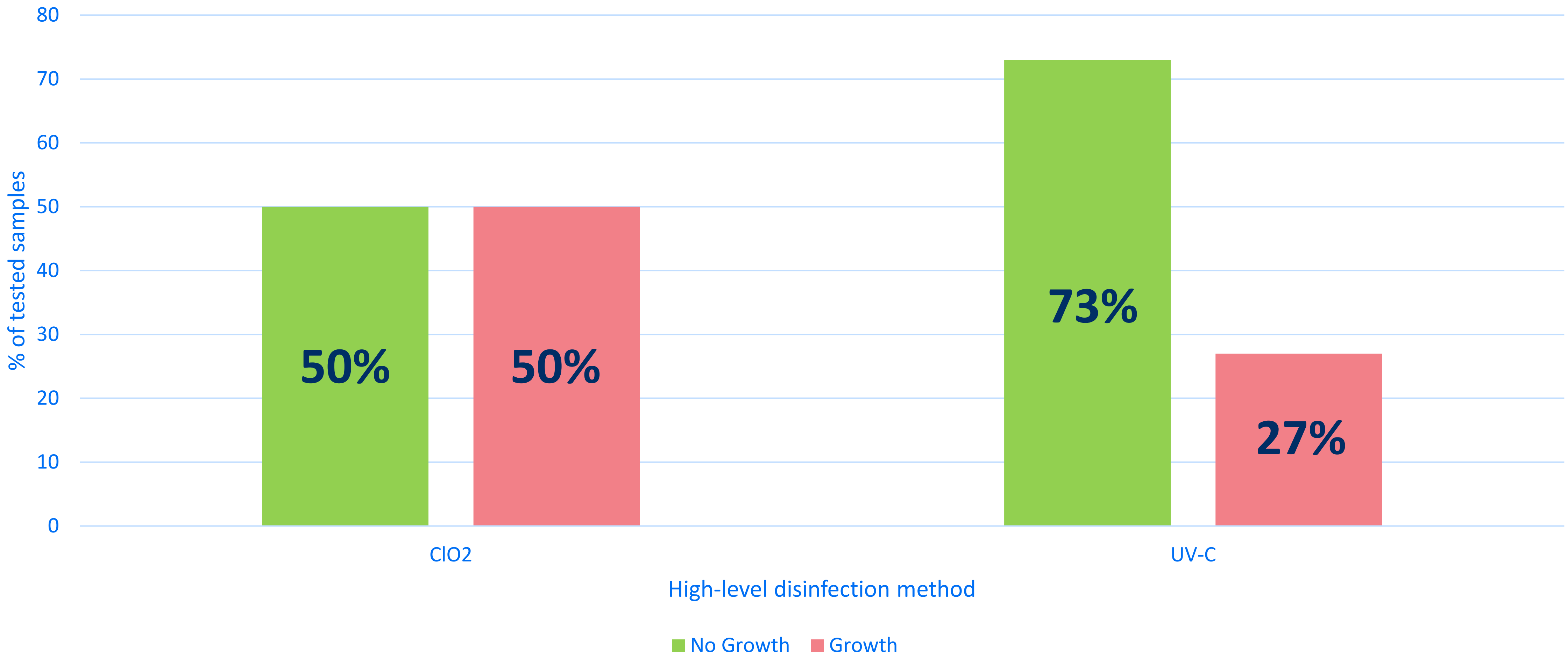


Obtained results

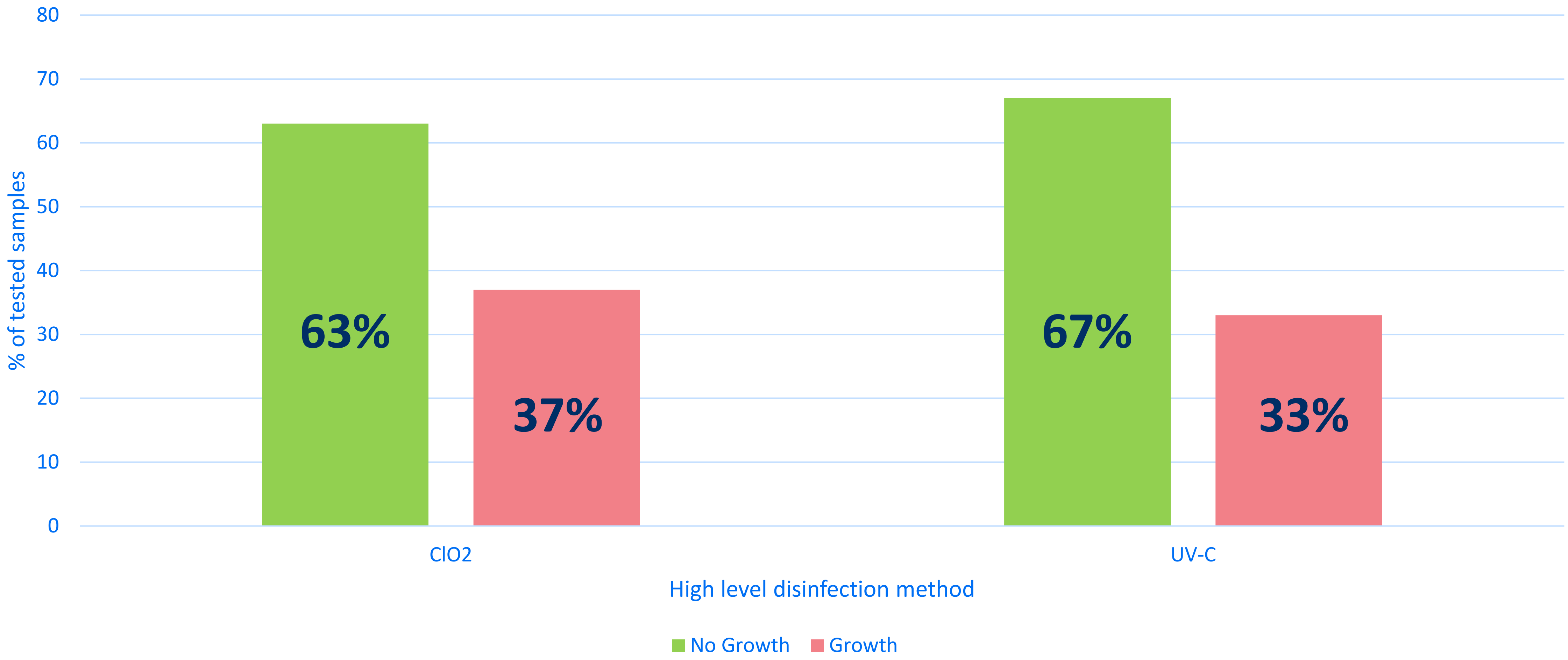
Visible contamination after disinfection



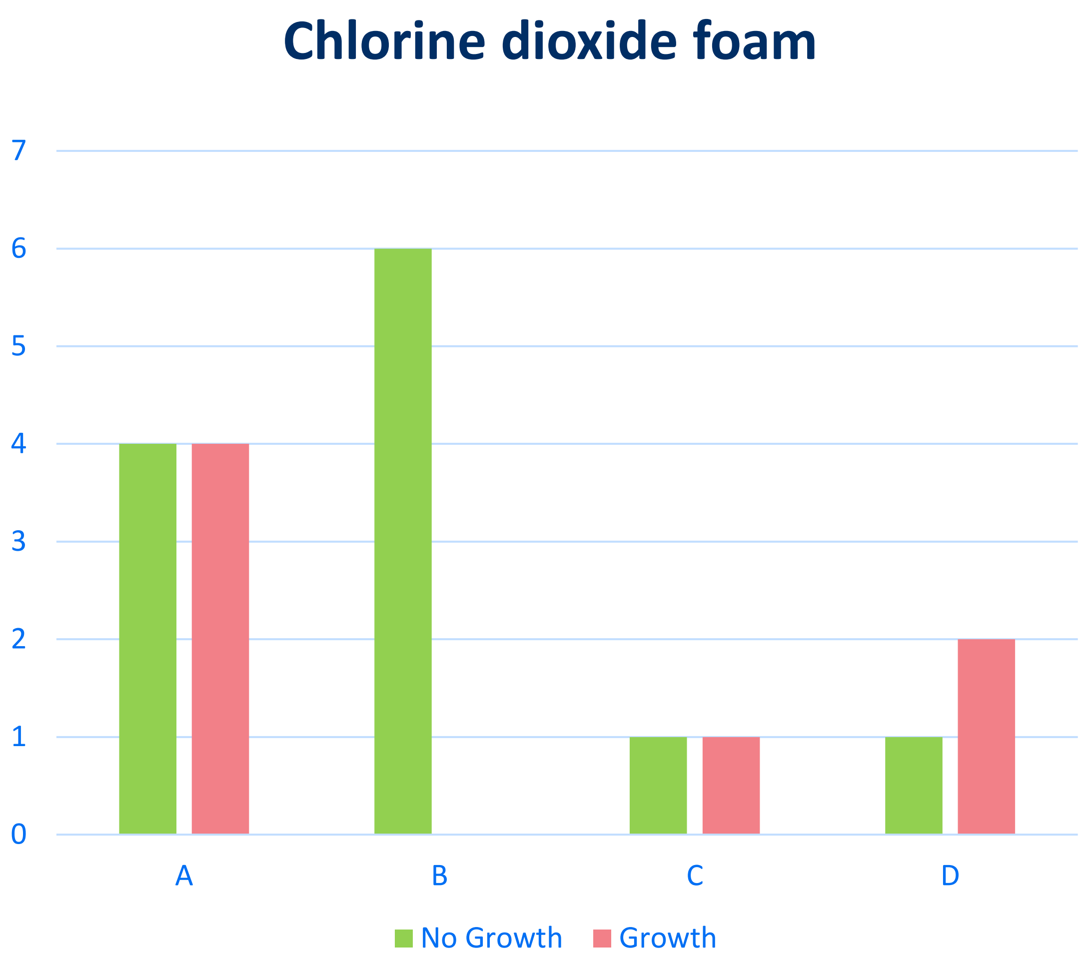
Detected microbiological growth: overview

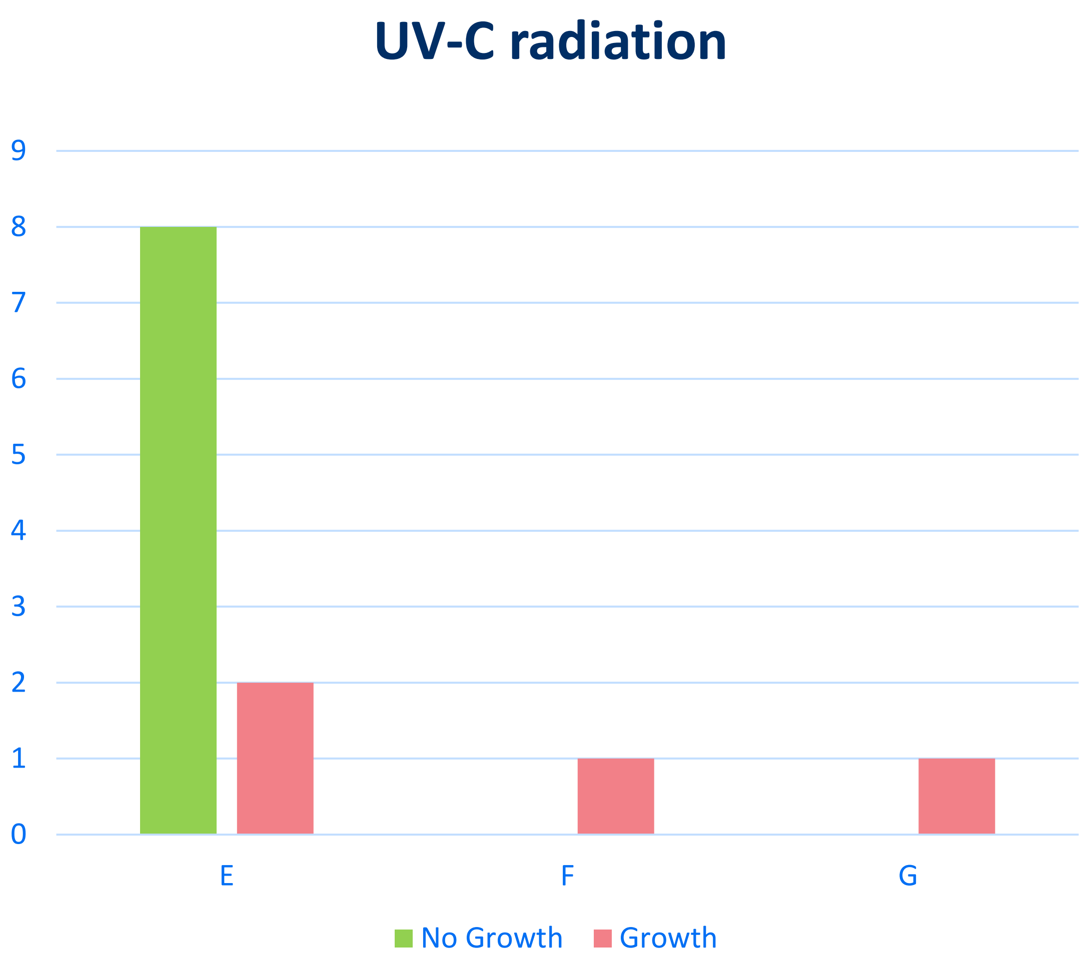


Detected microbiological growth: Doctors

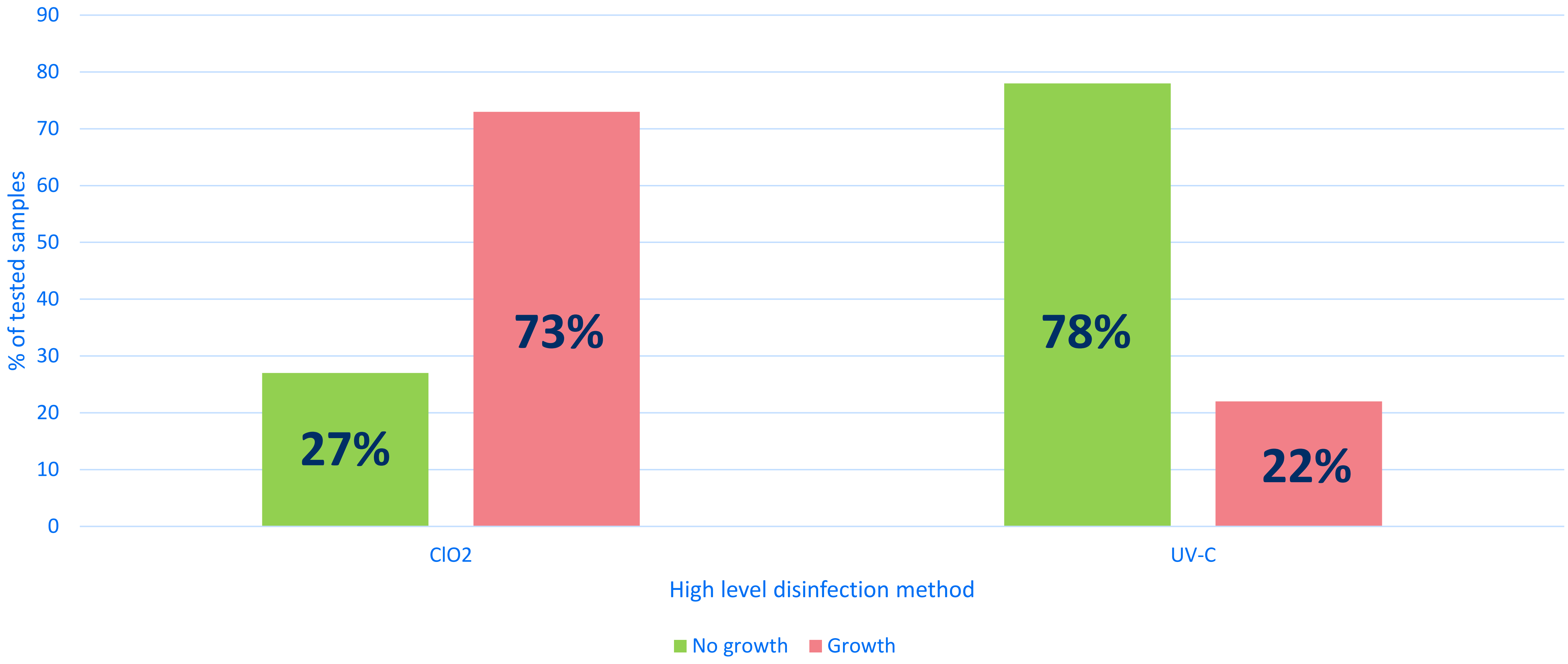


Detected microbiological growth: Doctors





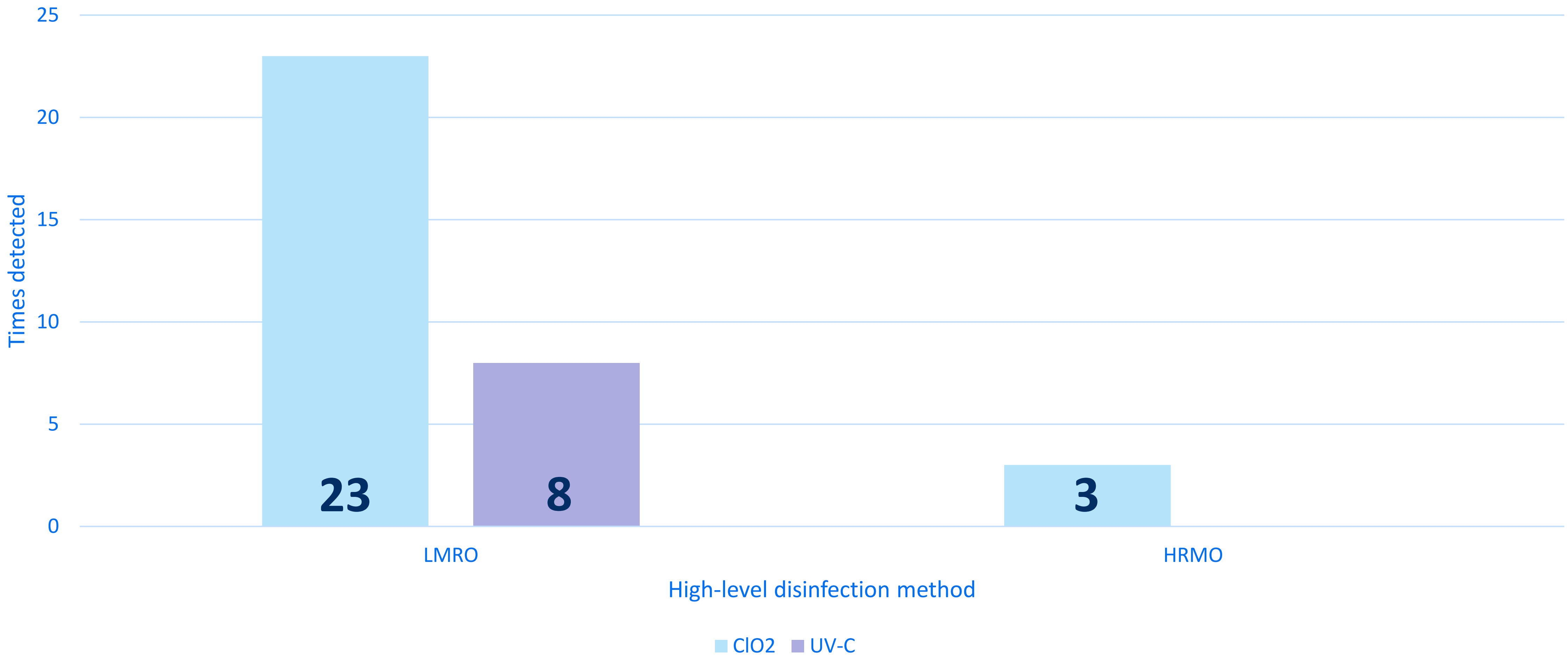
Detected microbiological growth: Residents



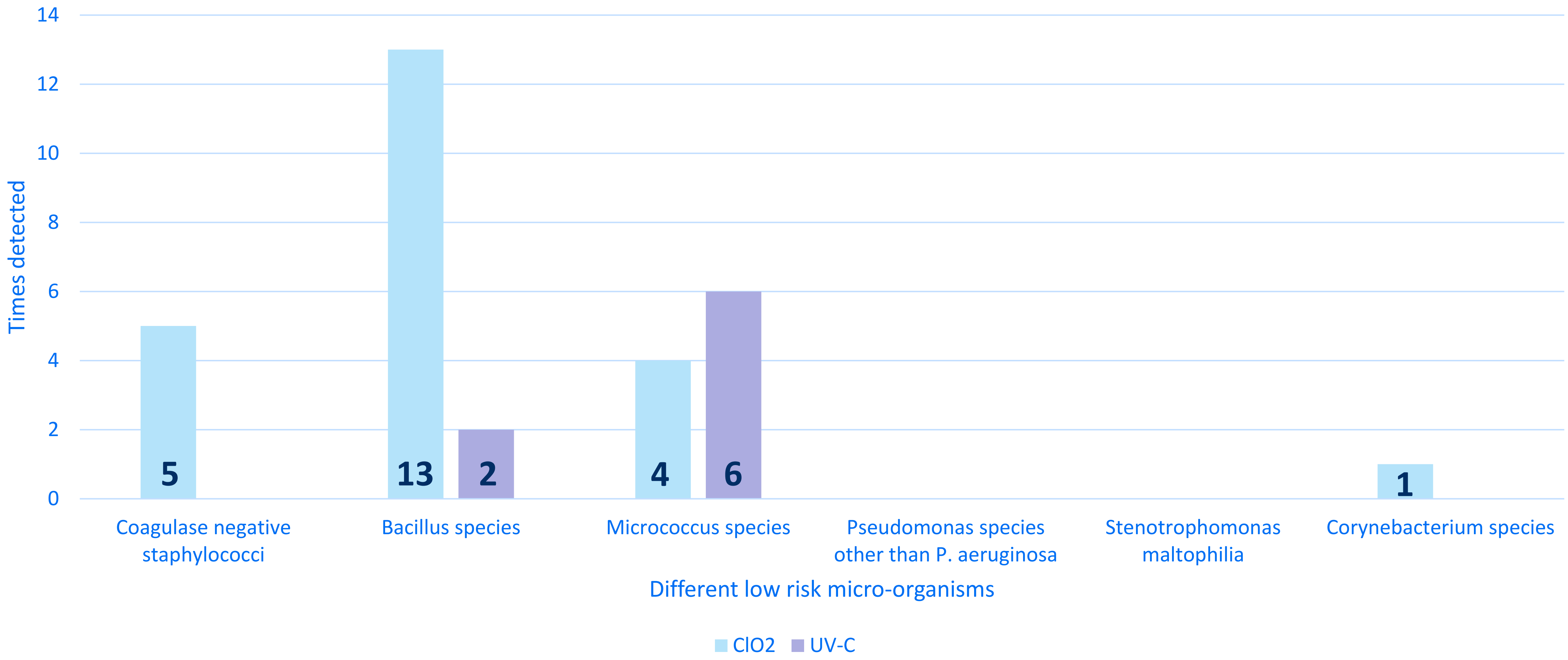
LRMO vs HRMO

Low risk micro-organisms	High risk micro-organisms
Coagulase negative staphylococci	Enterobacteriaceae
Bacillus species	Enterococci
Micrococcus species	Staphylococcus aureus
Corynebacterium species	Yeast
Pseudomonas species other than P. aeruginosa	Pseudomonas aeruginosa
Stenotrophomonas maltophilia	Acinteobacter species
	Streptococcus viridans

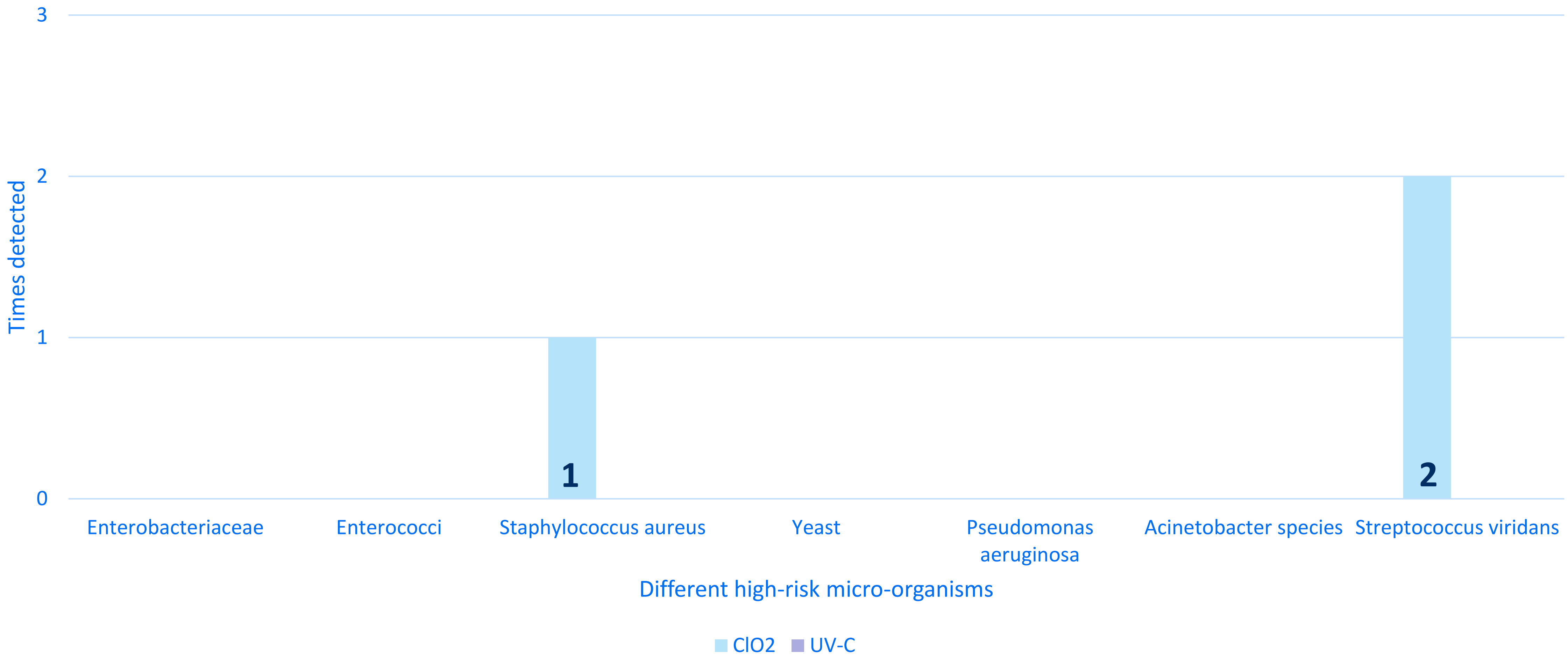
Detected high and low risk micro-organisms



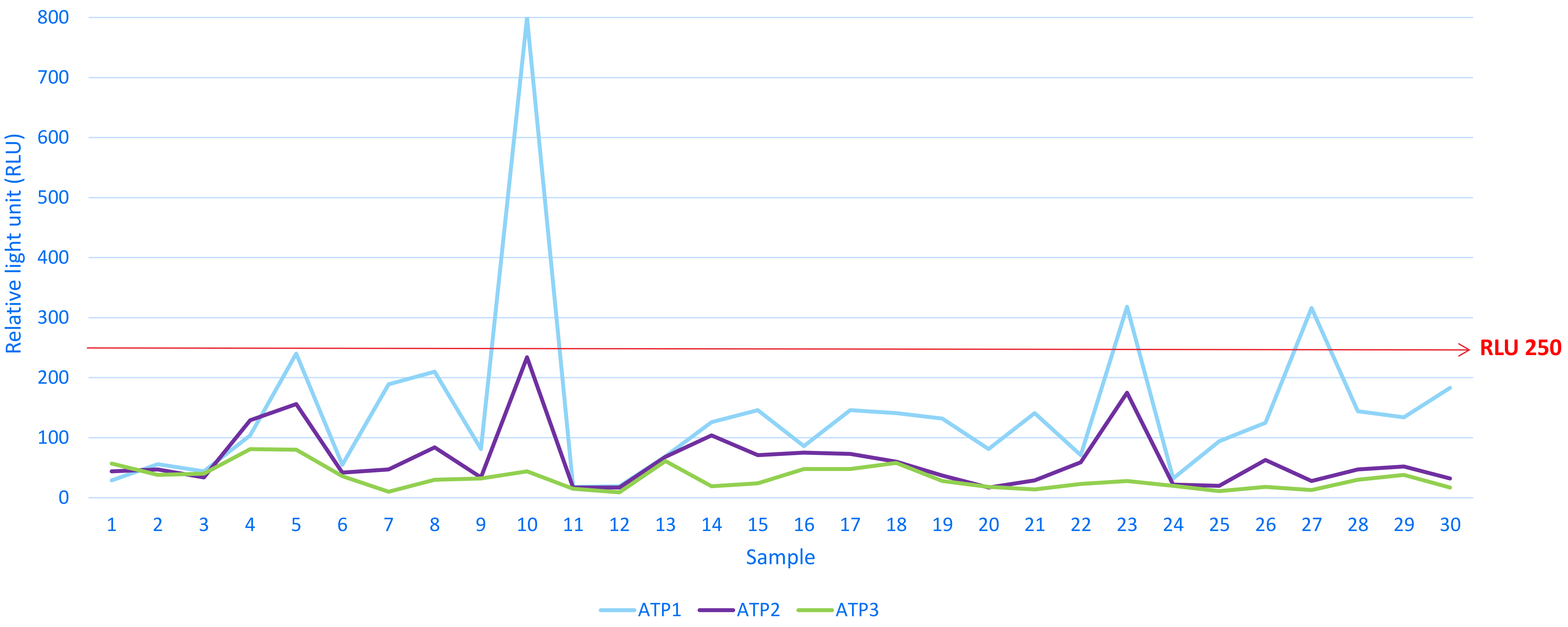
Detected LRMO after high level disinfection



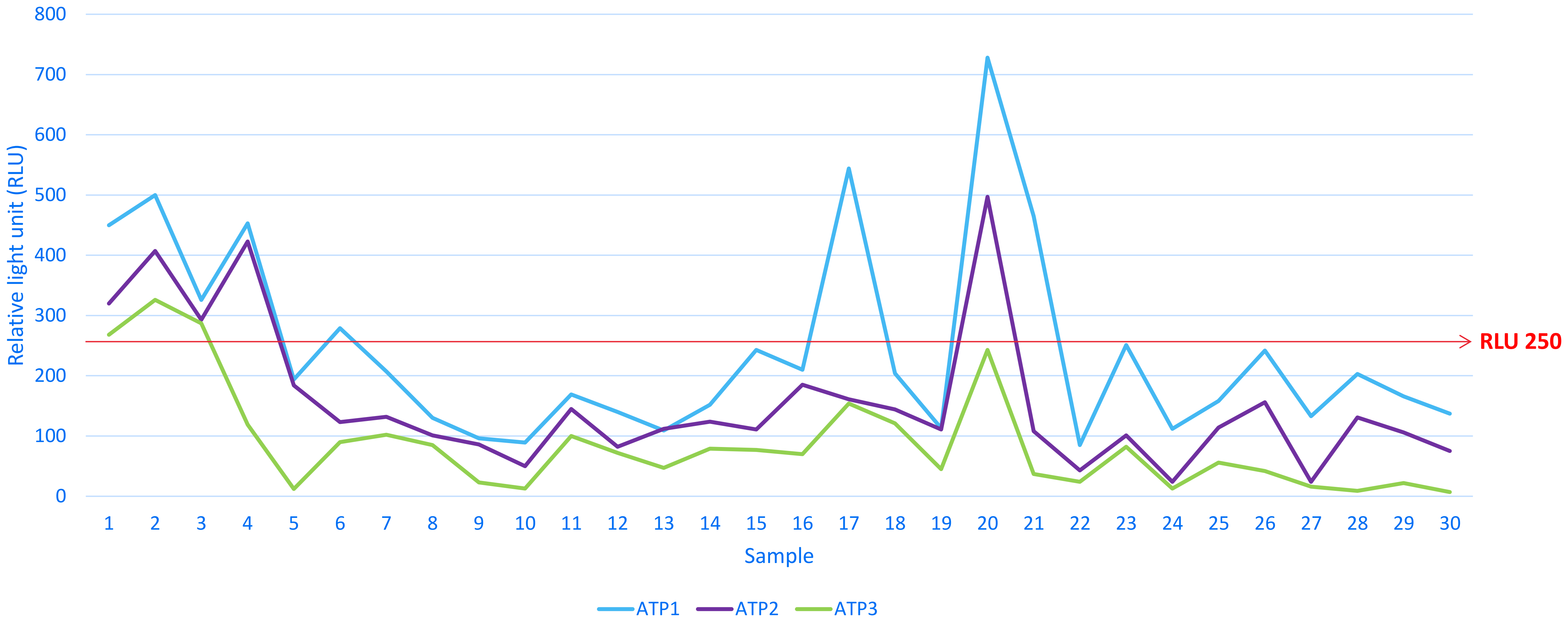
Detected HRMO after high-level disinfection



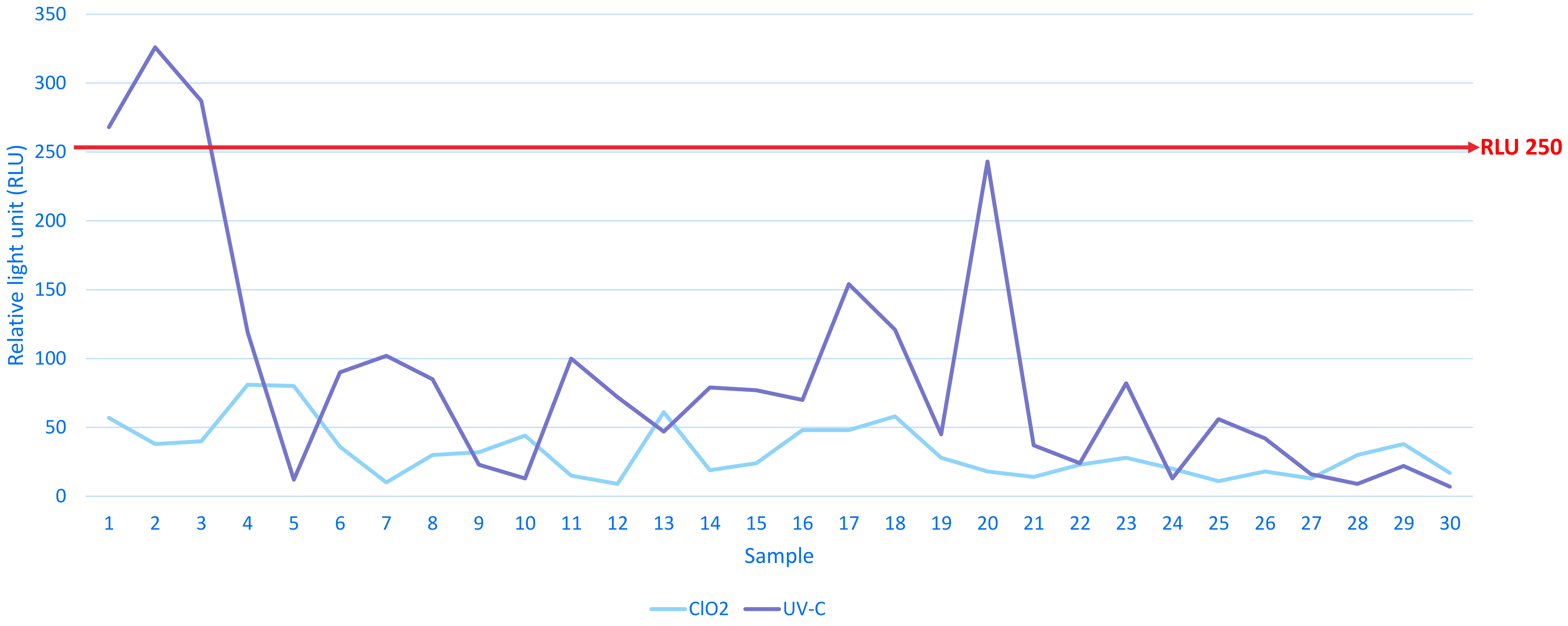
ATP measurements: Chlorine dioxide foam



ATP measurements: UV-C radiation



Comparison of the obtained ATP3 values



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Cost benefit analysis

Chlorine dioxide foam	
€/vial	133,33
#procedures/vial	155
€/200 wipes	14,33
€/wipe	0,07
€/procedure	**0,93**

UV-C radiation	
€/UV-C machine	13.450
€ annual maintenance (for 9 years)	12.150
Lifespan UV-C machine	10 years
€/year	2.560
€/day (weekends not included)	9,85
#procedures/day	± 10
€ electricity/procedure	0,1
€/procedure	**1,08**

Table 3: Calculated price per procedure for each high level disinfection method.

Chlorine dioxide foam	UV-C radiation
Installation costs	
No costs	Providing a table for the device or attachment to the wall
Operational costs	
Cost of new vials and wipes	Cost of electricity
Consumables	
Waste processing of the empty bottles and used wipes	None
Indirect costs	
Adequate education	Less complex
Logistic costs	
More storage necessary for the vials	No additional storage needed
Time costs	
Manual method ± 30 second contacttime	Placing probe in the machine (± 10 seconds)

Table 5: Additional costs for each high level disinfection method that should be taken into account.

Cost benefit analysis

Aspect	Chlorine dioxide foam	UV-C radiation
Effectivity	High	High
Safety staff	Chemical irritation	No exposure
Environmental impact	Chemical waste	No chemical waste

Conclusions

	Chlorine dioxide foam	UV-C radiation
Visible contamination	Less	More
Microbiological results	No significant differences	
Doctors	No significant difference	
Residents	Significant difference	
HRMO	Three detected	Zero detected
LRMO	More	Less
ATP3 measurements	Significant difference	

Choice based on situation and needs of the organization

Chlorine dioxide foam	UV-C radiation
Manual	Automated
Incidental use	High throughput use
	

Perspectives

- Testing on a larger scale
- Testing more high level disinfection methods
- New insights
- More informed decisions for optimizing the disinfection process

Obtained impact in AZ Klina

- Valuable new insights
- Hospital Hygiene Committee
- Hospital acquired 4 UV-C devices
- More interest in high level disinfection methods.
- Preference for UV-C
- NKO & Urology?

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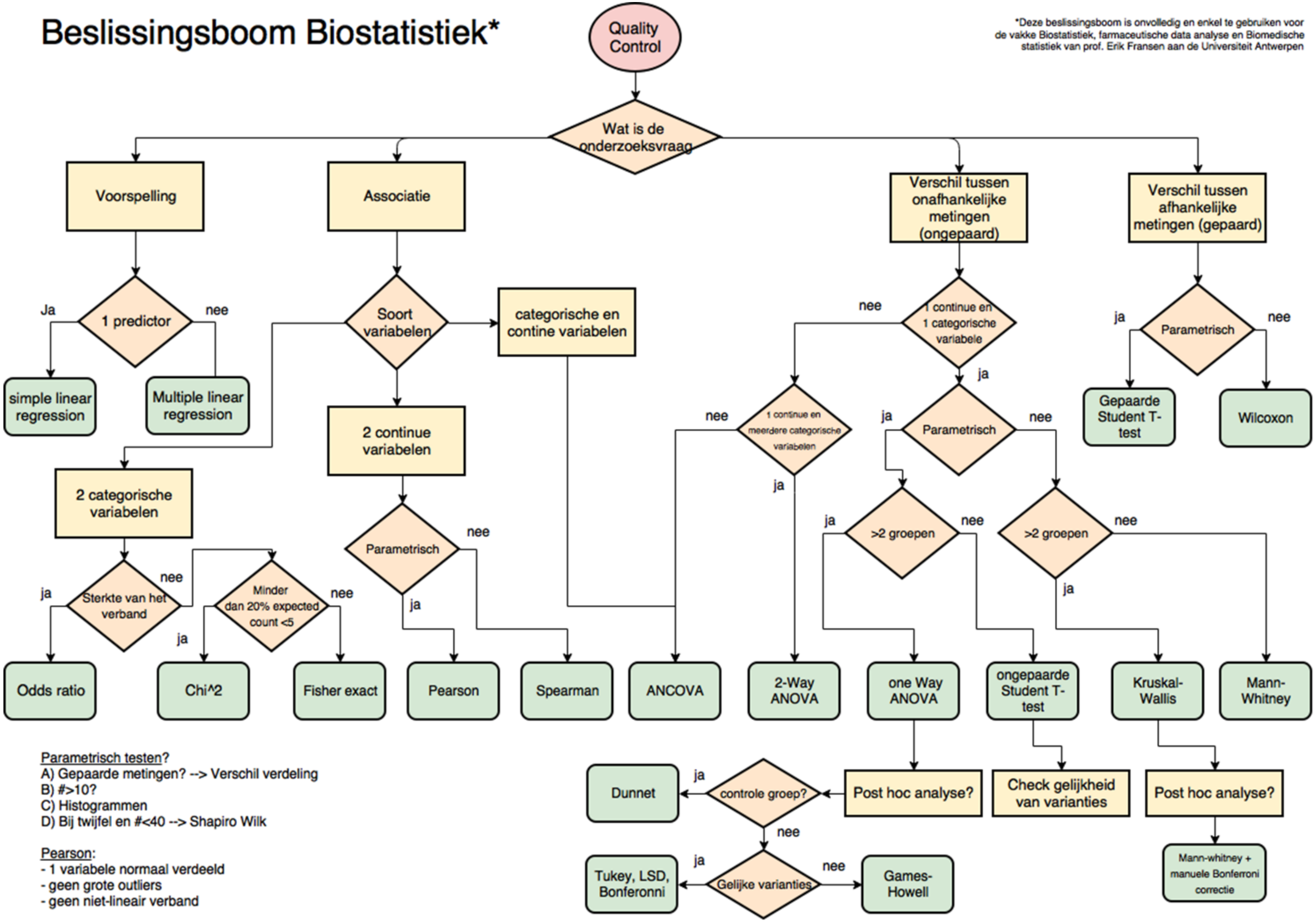
THANK YOU

Beslissingsboom Biostatistiek*

*Deze beslissingsboom is onvolledig en enkel te gebruiken voor de vakke Biostatistiek, farmaceutische data analyse en Biomedische statistiek van prof. Erik Fransen aan de Universiteit Antwerpen



Parametrisch testen?
A) Gepaarde metingen? --> Verschil verdeling
B) #>10?
C) Histogrammen
D) Bij twijfel en #<40 --> Shapiro Wilk

Pearson:
- 1 variabele normaal verdeeld
- geen grote outliers
- geen niet-lineair verband

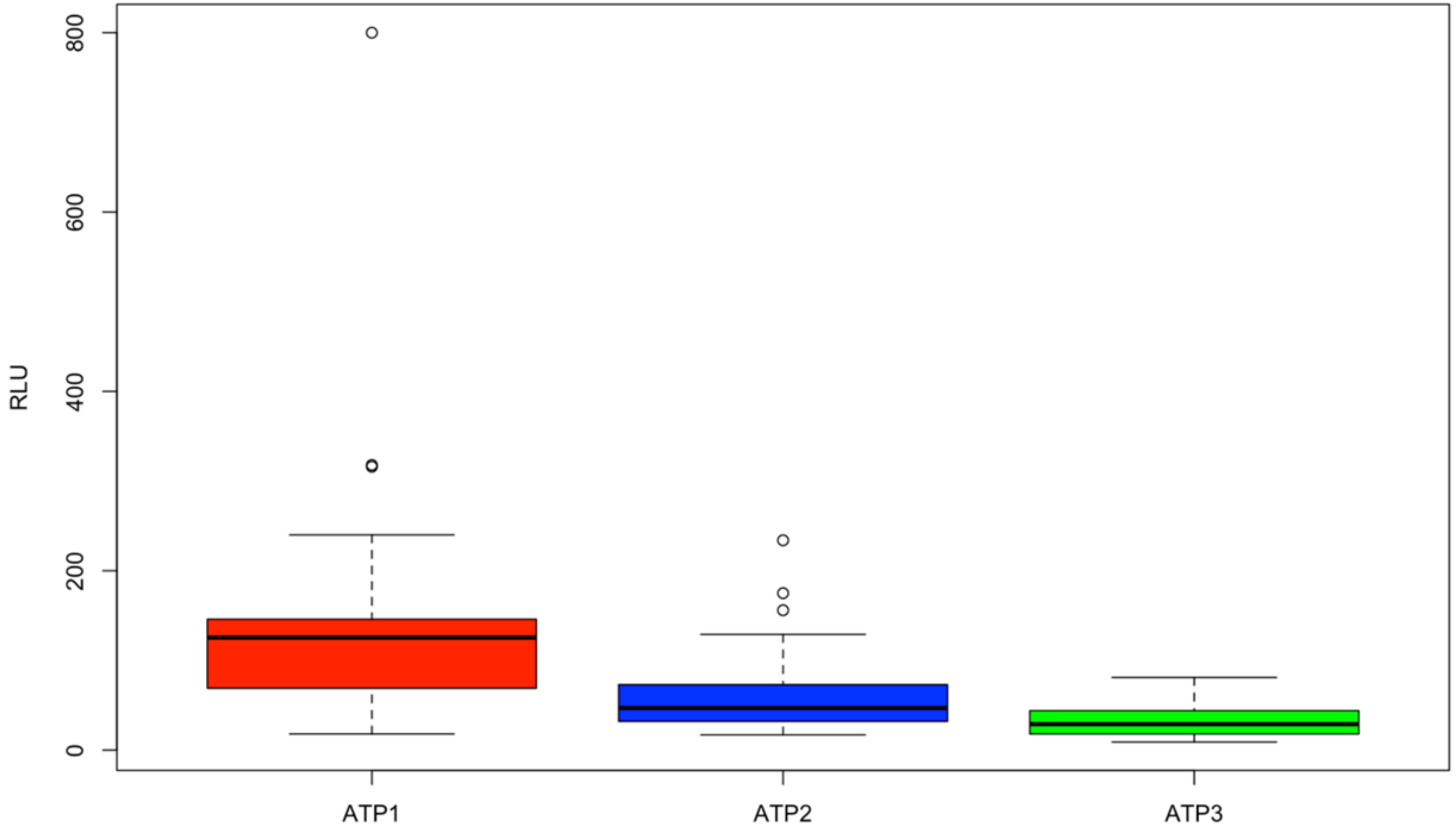
Addendum I: Visible contamination after disinfection

```
          Fisher's Exact Test for Count Data

data:  data1
p-value = 0.1042
alternative hypothesis: true odds ratio is not equal to 1
95 percent confidence interval:
 0.04104462 1.23602729
sample estimates:
odds ratio
 0.2650674
```

Addendum II: Microbiological growth after disinfection

```
        Fisher's Exact Test for Count Data

data:  data
p-value = 0.1102
alternative hypothesis: true odds ratio is not equal to 1
95 percent confidence interval:
 0.8275943 9.4174424
sample estimates:
odds ratio
  2.702425
```

Addendum III: ATP measurements after disinfection with chlorine dioxide foam



Addendum III: ATP measurements after disinfection with chlorine dioxide foam

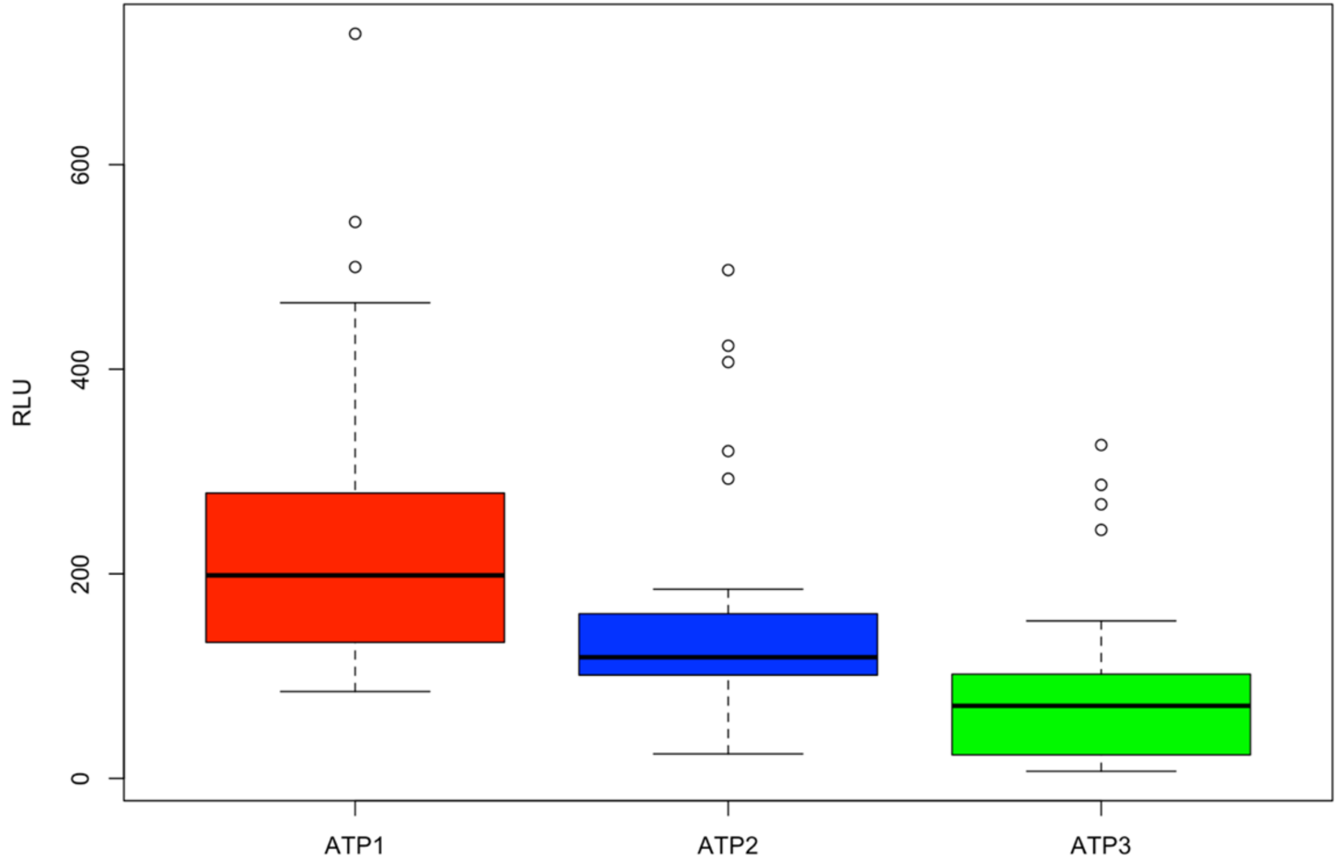
	ATP1 (RLU)	ATP2 (RLU)
ATP1 (RLU)	1.00000000	0.7542893
ATP2 (RLU)	0.75428925	1.0000000
ATP3 (RLU)	0.07955122	0.4938493
Measurement	0.07467391	-0.2148583

	ATP3 (RLU)	Measurement
ATP1 (RLU)	0.07955122	0.07467391
ATP2 (RLU)	0.49384930	-0.21485827
ATP3 (RLU)	1.00000000	-0.47915877
Measurement	-0.47915877	1.00000000

Addendum III: ATP measurements after disinfection with chlorine dioxide foam

```
        Friedman rank sum test

data:  Value and Condition and Measurement
Friedman chi-squared = 46.867, df = 2, p-value = 6.653e-11


        Pairwise comparisons using Wilcoxon signed rank test with continuity correction

data:  ATP_long$Value and ATP_long$Condition

           ATP1 (RLU) ATP2 (RLU)
ATP2 (RLU) 4.7e-05    -
ATP3 (RLU) 1.3e-05    4.0e-05

P value adjustment method: bonferroni
```

Addendum IV: ATP measurements after disinfection with chlorine dioxide foam



Addendum IV: ATP measurements after disinfection with chlorine dioxide foam

	ATP1 (RLU)	ATP2 (RLU)	ATP3 (RLU)
ATP1 (RLU)	1.0000000	0.8167278	0.7214559
ATP2 (RLU)	0.8167278	1.0000000	0.8026785
ATP3 (RLU)	0.7214559	0.8026785	1.0000000

Addendum IV: ATP measurements after disinfection with chlorine dioxide foam

```
        Friedman rank sum test

data:  Value and Condition and Measurement
Friedman chi-squared = 58.067, df = 2, p-value = 2.46e-13

        Pairwise comparisons using Wilcoxon signed rank test with continuity correction

data:  ATP_long1$Value and ATP_long1$Condition

           ATP1 (RLU) ATP2 (RLU)
ATP2 (RLU) 6.7e-06    -
ATP3 (RLU) 5.5e-06    5.5e-06

P value adjustment method: bonferroni
```

Addendum V: Comparing obtained ATP3 results

```
        Welch Two Sample t-test

data:  ATP3_Tristel and ATP3_UVC
t = -3.4008, df = 31.975, p-value = 0.00182
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -88.10337 -22.09663
sample estimates:
mean of x mean of y
 32.93333  88.03333
```

Addendum VI: Calculations cost benefit analysis chlorine dioxide foam

- Cost chlorine dioxide foam per procedure
  - €133,33 (cost 1 vial) / 155 (# of procedures for 1 vial) = €0,86
- Cost wipe per procedure
  - €14,33 (Price for 200 wipes) / 200 = €0,07
- **Total cost per procedure**
  - **€0,86 + €0,07 = €0,93**
- Total cost over 10 years
  - €0,93 * 26.000 procedures = €24.180

Addendum VII: Calculations cost benefit analysis UV-C radiation

- Variable costs
  - Electricity per procedure
    - Disinfection cycle = 75 seconds
    - Energy consumption = +/- 220 kWh
    - Energy consumption per procedure
      - = 0,220 kW * 0,021 hour = 0,00462 kWh.
    - Electricity per procedure
      - = 0,00462 kWh * €0,10/kWh = €0,000462 per cycle
      - For the simplicity of the calculations rounded to +/- €0,10
  - Electricity over 10 years = €2.600

- Fixed costs
  - €13.450 (purchase price) + €12.150 (annual maintenance for 9 years) = €25.600
  - Price per procedure per year
    - = €25.600 / 10 = €2.560
  - Price per procedure per day
    - = €2.560 / 260 = €9,85
  - **Price per procedure**
    - **= €9,85 / 10 = €0,98**

- Total costs UV-C radiation over 10 years = € 25.600 + €2.600 = €28.200
- **Cost per procedure with variable cost included**
  - **€28.200 / 26.000 procedures = €1,08**