MEDISET CHIRONAX

99Technologies

The role of medical equipment in the spread of HAI

Environmental surfaces contamination in healthcare settings

- It is now widely recognized that the environment and equipment may facilitate the transmission of several health-care associated pathogens.

- Environmental screening have shown that pathogens are prevalently found in **<u>hand-touch frequency surfaces (such as medical equipment)</u>**

  - *Clostridium difficile*
  - *Methicillin-resistant Staphylococcus aureus* (MRSA)
  - *Vancomycin-resistant enterococci* (VRE)
  - *Norovirus*
  - Multi-drug resistant (MDR)gram-negative rods (including *Acinetobacter baumannii)*

Share the ability to be shed from infected or colonized patients, survive on dry surfaces for extend periods, and are difficult to eradicate by cleaning and disinfection.

Epidemiological studies have demonstrated that after discharge of an infected or colonized patient, there will be an increased risk of acquisition of the same pathogen in the subsequent room occupant.

Survival time on surfaces of principal pathogens causing HAIs

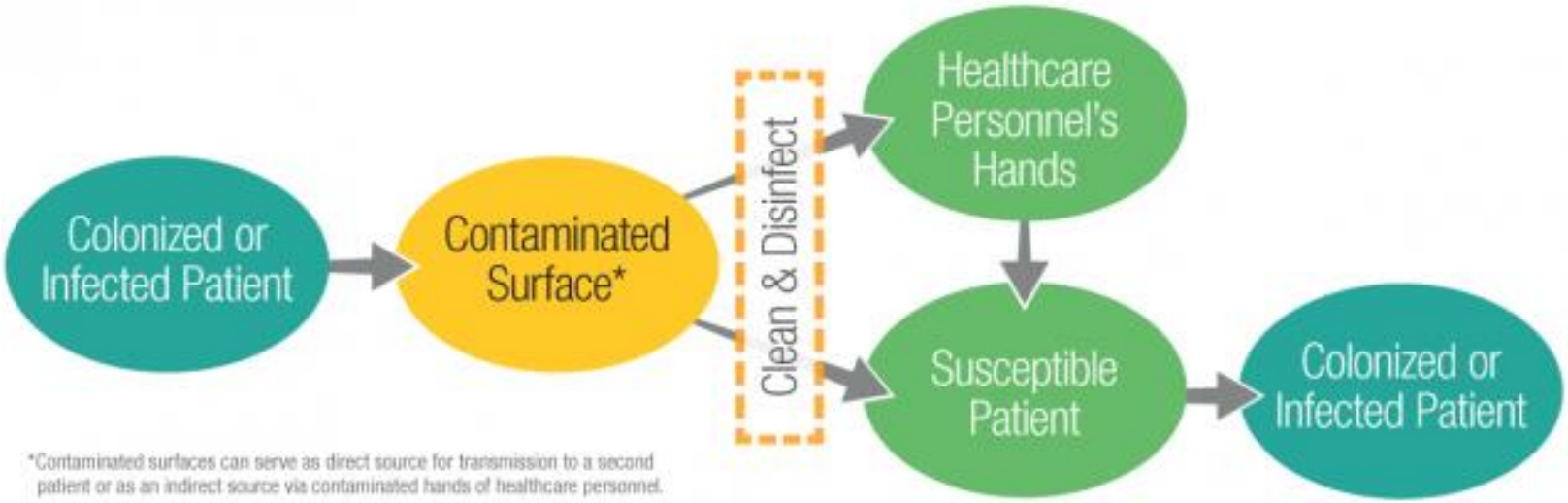
Microorganisms	Environmental survival time
Gram-negative bacteria	
Escherichia coli	From 1.5 hours to 16 months
Pseudomonas aeruginosa	From 6 hours to 16 months
Klebsiella spp.	From 2 hours to 30 months
Acinetobacter spp.	From 3 days to 5 months
Gram-positive bacteria	
MRSA	From 7 days to 7 months
VRE	From 5 days to 4 months
Clostridium difficile	> 5 months
Fungi	
Candida albicans	From 1 to 120 days
Viruses	
Norovirus	From 8 hours to 7 days

Source: *Facciolá A. et al., The role of the hospital environment in the healthcare-associated infections: a general review of the literature, European Review for Medical and Pharmacological Sciences, 2019; 23: 1266-1278*

Transmission of Microorganisms through Contaminated Surfaces

The healthcare environment contains a diverse population of microorganisms. Surfaces contaminated with microorganisms can serve as reservoirs of potential pathogens. Contamination of surfaces, including high-touch surfaces in the room and reusable patient care equipment that is moved between rooms, can lead to:

- Transmission to the next patient who occupies the room or uses the same equipment
- Contamination of the hands or clothing of healthcare personnel with transmission to other patients



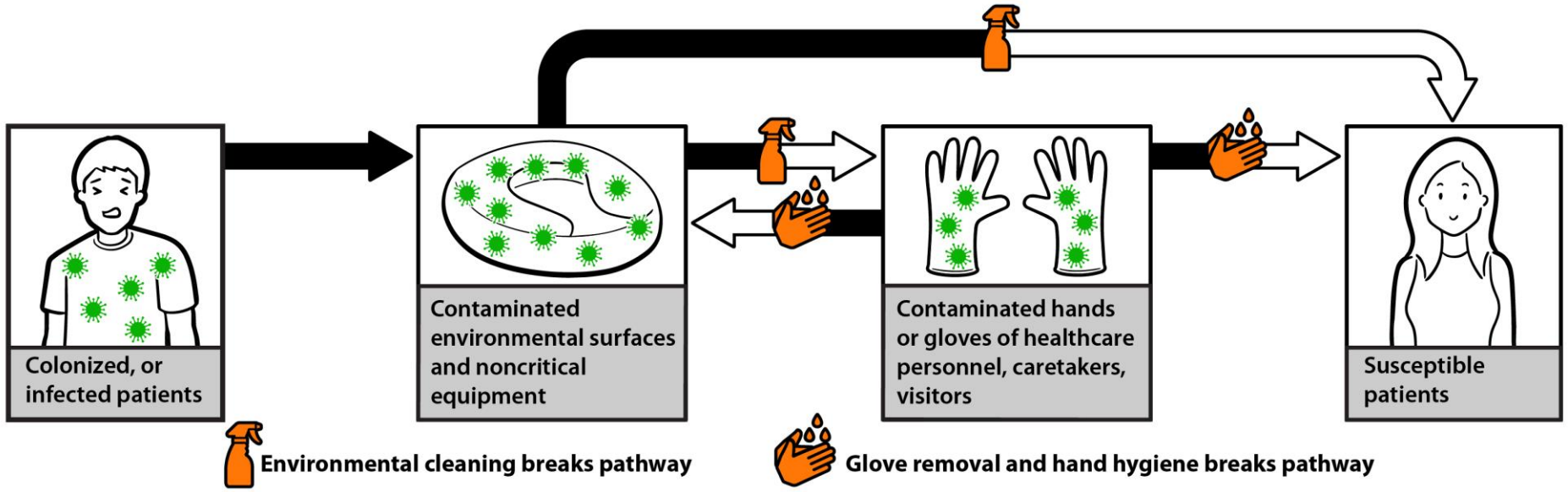
Source: *https://www.cdc.gov/hai/prevent/environment/surfaces.html*

How to break the transmission pathway

Microorganisms are transferred from the environment to a susceptible host through:

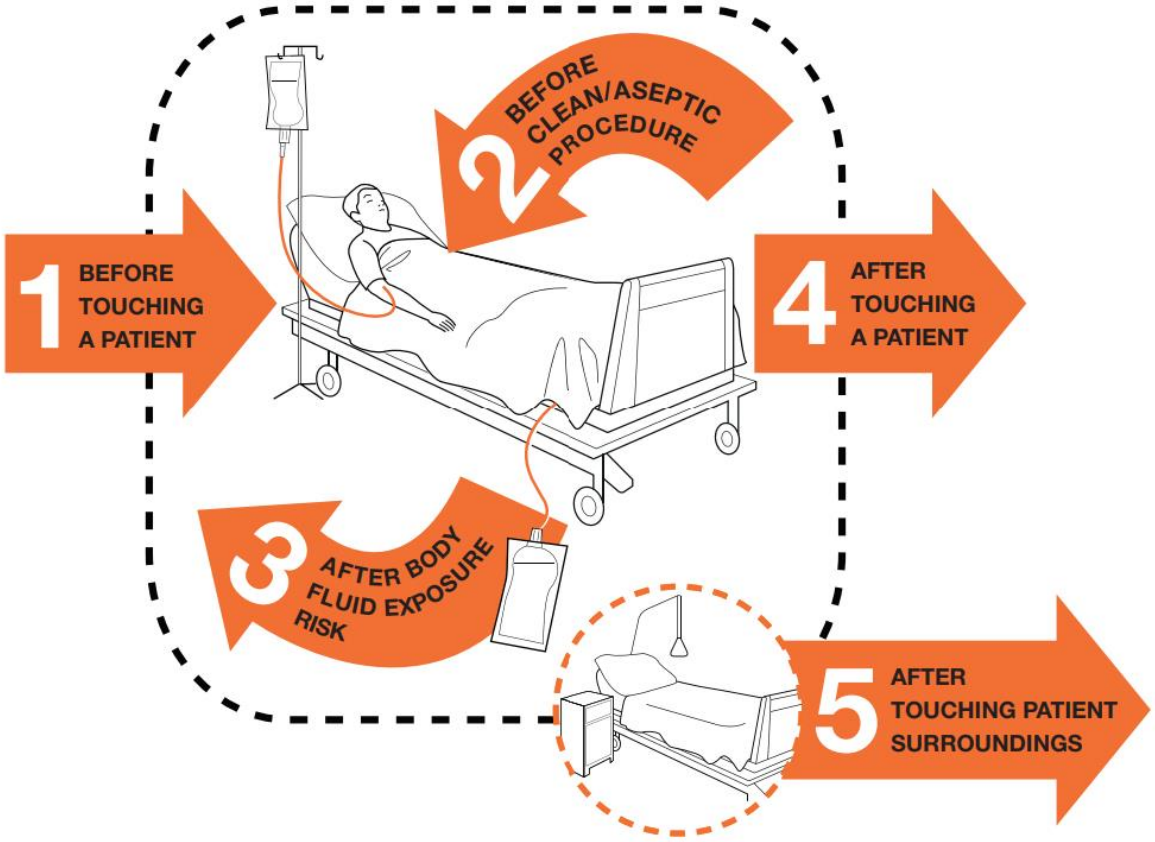
- Contact with contaminated environmental surfaces and noncritical equipment
- Contact with contaminated hands or gloves of healthcare workers during the provision of care, as well as by caretakers and visitors

Cleaning and hand hygiene (preceded by glove removal, as applicable) can break this chain of transmission



Source: *https://www.cdc.gov/hai/prevent/resource-limited/introduction.html*

Issues with hand hygiene breaks pathway



Five moments for hand hygiene promoted by WHO

Despite its simplicity, hand hygiene is still poorly practiced in many health care facilities.

- 1 in 3 facilities lack hand hygiene facilities at the point of care.
- Compliance with hand hygiene best practices is only around 9% during care of critically ill patients in low-income countries.
- Levels of hand hygiene compliance for high-income countries rarely exceed 70%, calling for additional efforts to improve practices all over the world

Source:*https://www.who.int/campaigns/world-hand-hygiene-day/2021/key-facts-and-figures*

Issues with environmental cleaning breaks pathway

Considering the issues with hand hygiene before mentioned, an effective cleaning and disinfection of the environment and equipment is of utmost importance to reduce the chance of cross-contamination and infections. However, ordinary manual cleaning and disinfection have important limitations

- Process affected by human errors (rush, operator's accuracy and motivation affect a lot the outcomes).
- Impossibility to establish if all surfaces have been uniformly treated (complex geometry, cables, etc.).
- Impossibility of verifying if contact time has been correctly respected.
- Process not replicable and many variables to control.
- Often products are diluted down before the use with the possibility of making a mistake in the effective concentration.

When we can consider the equipment's surface well disinfected?

Currently there are no standards or legislative references for the evaluation of the levels of microbial contamination of the surfaces.

However, several studies have been working to define benchmark values, which are finalized to estimate the efficacy of disinfection or to quantify and provide a general measure of bacterial load.

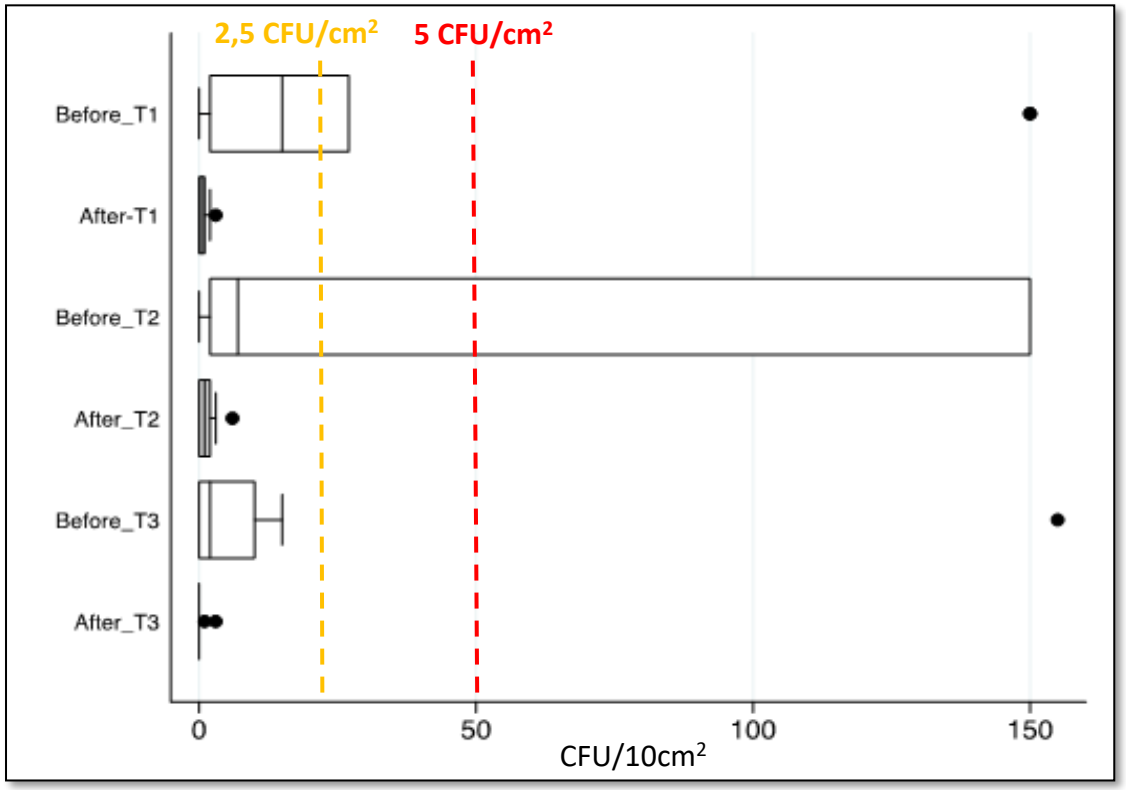
According to these studies two benchmarks have been proposes for ACC are < 5 cfu/cm^2 or ACC < 2,5 cfu/cm^2

The presence of any pathogens (above all MDR) should be an alert!

According to 99Technologies' experience ordinary cleaning and disinfection of hospital surfaces and equipment do not guarantee compliance with such benchmarks.

CASE A: DIALYSIS CENTER IN LUGANO (SWITZERLAND)

Bacterial residual contamination in a dialysis center measured after the ordinary cleaning only (Before T1,2,3) and after the HyperDRYMist® Technology (After T1,2,3). Data detected on 3 different days (T1,T2,T3) are shown. Bacterial residual contamination is measured on 10 high touch-surface points at each time point.



MEDISET CHIRONAX

According to 99Technologies' experience ordinary cleaning and disinfection of hospital surfaces and equipment do not guarantee compliance with such benchmarks.

99Technologies

CASE B: HOSPITAL IN LODI (ITALY)

This study was conducted in order to evaluate the efficacy of HyperDryMist® over traditional manual cleaning with active chlorine solution in reducing MDR (multidrug resistant bacteria).

- 10 high-touch surfaces were sampled aftermanual difinfection with chlorine and after HDM treatment in 20 different rooms following patient's dishcarge. Each room was investigated for specific MDR detected in patients. Enriched culture media were used and the MDR bacteria were isolated.
- As shown in the table, **MDR bacteria were removed only after HDM treatment**

USE OF HDM Technology	Room 1 MRSA		Room 2 MRSA		Room 3 MRSA		Room 4 MRSA		Room 5 MDR A.baumanii	
	UFC/57cm² Pre	UFC/57cm² Post	UFC/57cm² Pre	UFC/57cm² Post	UFC/57cm² Pre	UFC/57cm² Post	UFC/57cm² Pre	UFC/57cm² Post	UFC/57cm² Pre	UFC/57cm² Post
Headboard	75	0	60	0	35	0	45	0	33	0
Footboard	52	0	250	0	2	0	24	0	70	0
Bed frame	25	0	200	0	1	0	9	0	95	0
Room door handle	45	0	27	0	100	0	50	0	100	0
Bedside table handle	30	0	220	1	80	2	40	2	16	0
Bedside table top	82	0	320	0	230	1	140	1	30	0
Light switch	26	0	18	0	6	0	23	0	5	0
Floor corner	70	1	350	0	400	3	320	3	145	1
Sink taps	118	1	360	0	50	0	45	0	32	0
Soap dispenser	18	1	15	1	130	1	30	1	3	0

USE OF HDM Technology	Room 6 MDR A.baumanii		Room 7 MDR P. aeruginosa		Room 8 MDR P. aeruginosa		Room 9 K. pneumoniae KPC		Room 10 K. pneumoniae KPC	
	UFC/57cm² Pre	UFC/57cm² Post	UFC/57cm² Pre	UFC/57cm² Post	UFC/57cm² Pre	UFC/57cm² Post	UFC/57cm² Pre	UFC/57cm² Post	UFC/57cm² Pre	UFC/57cm² Post
Headboard	20	0	12	0	150	0	5	0	50	0
Footboard	10	0	6	0	120	0	18	0	7	1
Bed frame	20	0	106	0	33	0	4	0	58	0
Room door handle	30	0	5	0	110	1	2	0	50	0
Bedside table handle	20	0	2	0	80	0	3	0	250	2
Bedside table top	45	0	6	0	150	0	5	0	300	1
Light switch	5	0	11	0	35	0	45	0	80	3
Floor corner	120	2	45	0	100	0	75	3	400	1
Sink taps	32	0	9	0	200	0	6	0	200	0
Soap dispenser	3	0	11	0	15	0	2	0	60	0

USE OF HDM Technology	Room 11 K. pneumoniae KPC		Room 12 K. pneumoniae KPC		Room 13 VRE		Room 14 VRE		Room 15 E.coli ESBL	
	UFC/57cm² Pre	UFC/57cm² Post	UFC/57cm² Pre	UFC/57cm² Post	UFC/57cm² Pre	UFC/57cm² Post	UFC/57cm² Pre	UFC/57cm² Post	UFC/57cm² Pre	UFC/57cm² Post
Headboard	0	0	32	0	59	0	89	0	59	0
Footboard	17	0	26	0	28	0	45	0	28	0
Bed frame	3	1	111	0	43	0	45	0	43	0
Room door handle	20	0	15	0	22	0	38	0	22	0
Bedside table handle	70	0	22	0	18	0	8	0	18	0
Bedside table top	1	0	15	0	50	0	60	0	50	0
Light switch	2	1	21	0	85	1	40	1	85	0
Floor corner	320	0	55	2	115	0	115	0	115	0
Sink taps	60	1	32	0	11	1	11	1	11	1
Soap dispenser	4	3	10	0	8	0	8	0	8	0

USE OF HDM Technology	Room 16 E.coli ESBL		Room 17 K. pneumoniae ESBL		Room 18 K. pneumoniae ESBL		Room 19 S.maltophylia T/S-R		Room 20 S.maltophylia T/S-R	
	UFC/57cm² Pre	UFC/57cm² Post	UFC/57cm² Pre	UFC/57cm² Post	UFC/57cm² Pre	UFC/57cm² Post	UFC/57cm² Pre	UFC/57cm² Post	UFC/57cm² Pre	UFC/57cm² Post
Headboard	29	0	11	0	20	0	66	0	11	0
Footboard	17	0	40	0	15	0	15	0	40	0
Bed frame	18	0	5	0	45	0	7	0	5	1
Room door handle	33	0	3	0	5	0	23	0	3	0
Bedside table handle	12	1	40	0	20	0	27	0	40	0
Bedside table top	22	0	3	0	30	0	35	0	3	0
Light switch	24	1	15	0	3	0	24	1	15	0
Floor corner	270	0	160	1	130	0	81	2	160	1
Sink taps	45	1	70	2	5	0	110	1	70	0
Soap dispenser	35	0	10	0	8	0	12	0	10	0

Table legend and color explanation

MDR Removed

Presence of the following MDR organisms

- MRSA
- Acinetobacter baumannii
- P. aeruginosa MBL
- K. pneumoniae KPC
- VRE
- E.coli ESBL
- K. pneumoniae ESBL
- S.maltophylia TMP/SMX-R

Automated disinfection systems based on H_2O_2 as additional tool

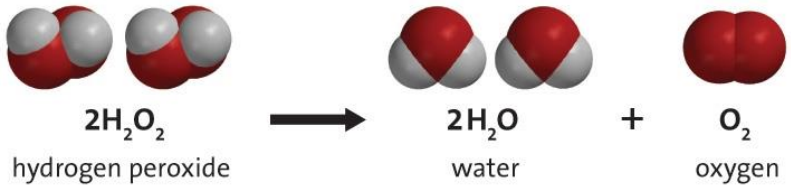
- In the two cases previously shown, we have seen how the use of an automated H_2O_2 -based disinfection system HyperDryMist® made it possible to bring the levels of microbial contamination still present on the surfaces after manual disinfection within the safety levels defined by the benchmarks.

- This system consists of a device capable of micro-nebulizing the disinfectant solution into the environment, **creating a hyper dry mist with droplet size < 1µm**, which reaches all points of the exposed equipment's surfaces, even the most difficult to reach manually.

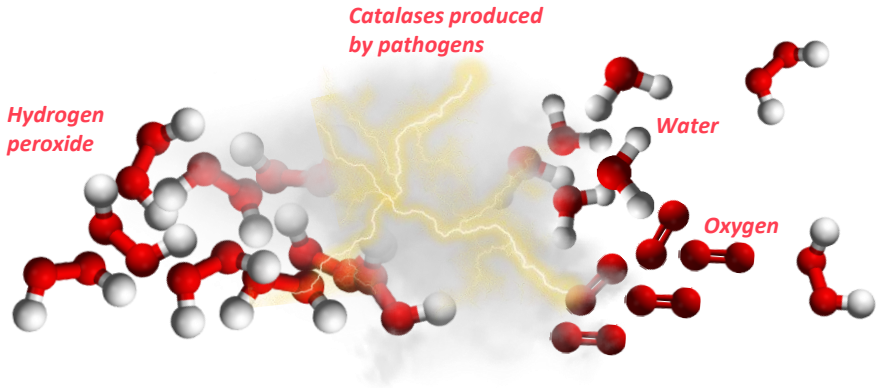
- There are various disinfection systems based on the aerosolization of H_2O_2 solutions. Although apparently similar, there are important differences between these systems, first of all the disinfectant solution they use and the quality of the aerosol.

- **Very small droplet size is important to allow the solution to reach all points and to create a continuous microscopic layer on the treated surfaces without leaving humidity residue.**
- **Aerosolized H_2O_2 at the concentrations and doses of applications of the most common automated disinfection systems has important limitations…**

Limitations of ordinary Hydrogen Peroxide solution



Hydrogen peroxide is unstable and it naturally tends to decompose into oxygen and water. The interaction with organic residues can catalyze hydrogen peroxide's degradation and decrease its efficacy.



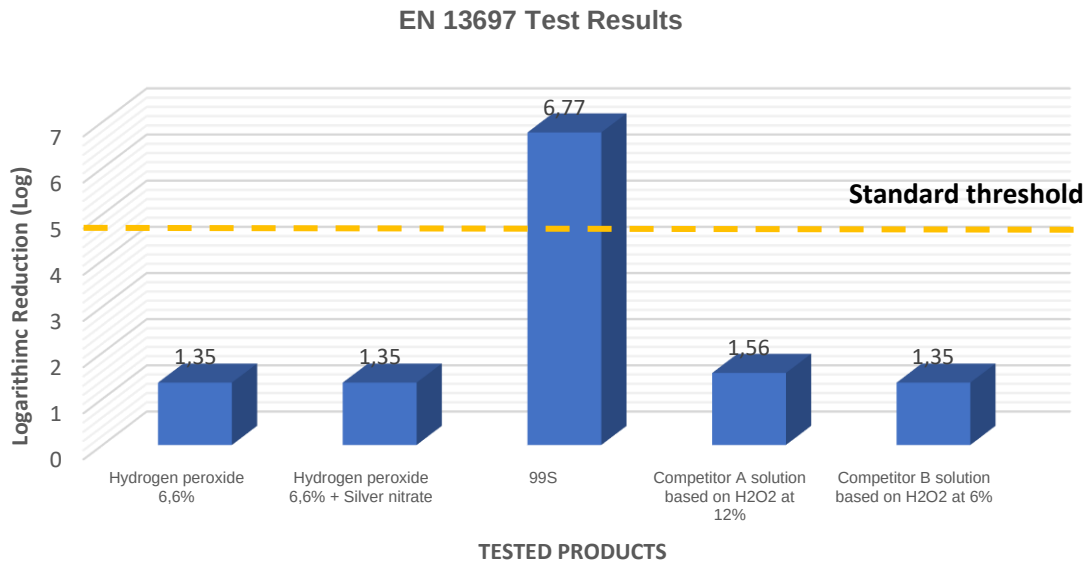
Catalase producing pathogens:

- *Staphylococcus aureus*
- *Acinetobacter baumannii*
- *Klebsiella pneumoniae*
- *Escherichia coli*
- *Candida albicans*
- *Bacillus subtilis*
- *Aspergillus*
- *Mycobacterium tuberculosis*
- Many other microorganisms

Catalases and other peroxidases produced by several microorganisms as self-defense mechanisms can reduce hydrogen peroxide's efficacy and require higher concentration and longer contact times!

New H_2O_2 based solution that goes beyond the active's limitations

- In order to verify the effective impact of catalase on hydrogen peroxide, comparison test between the 99S, where hydrogen peroxide is protected and reinforced from the synergy with other co-formulants, and other solutions whose efficacy is purely based on hydrogen peroxide at medium-low concentrations.
- The comparison test has been performed from an independent and accredited laboratory following the EN 13697.
- The test was carried out on the *Staphylococcus aureus* bacterium, considered as the most challenging microorganism for disinfectants based on hydrogen peroxide as it owns a complex antioxidant defence mechanism which includes catalase.



> 100.000 TIMES MORE EFFECTIVE!!!

MEDISET CHIRONAX

Conclusive thoughts…

99Technologies

- Contaminated surfaces of medical equipment play an important role in the spread of HAI.
- It is of utmost importance to abide by strict equipment's surfaces disinfection protocols and to monitor the effectiveness of such procedures.
- Ordinary manual disinfection is not always enough to guarantee a uniform treatment of all equipment's surfaces.
- Additional tools and technology, as H_2O_2 based automated disinfection systems, can be implemented to obtain better results. However, simple H_2O_2 solutions are not sufficient as most of pathogens can defend themselves from hydrogen peroxide (because of the catalase enzyme).
- To overcome limitations above mentioned limitations, new solutions which rely on the synergism of H_2O_2 and co-formulants can be exploited.
- Finally, it would help to have formal benchmarks issued and recognized by health authorities.

…Can we then do more?

Thanks for the attention!
Any questions?