Interclean Healthcare Cleaning Forum

What's new in HEH innovation: special focus on room disinfection

Edmée Bowles, The Netherlands

Clinical microbiologist
Head of Infection Prevention
Department of Medical Microbiology
Radboudumc Center for Infectious Diseases

Automated Whole Room Disinfection

Why, What and How

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Edmée Bowles, clinical microbiologist

Radboudumc, Nijmegen

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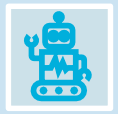
No disclosures

Content



Why automated room disinfection?

What?

Hydrogen peroxide

Ultraviolet-C light

How does it work?

Validation of UV-C in Radboudumc

Why automated room disinfection?

- Europe: 4.100.000 healthcare associated infections (HAI)/year*
- 90.000 deaths/year*
- Growing problem of antimicrobial resistance.
- Patients have an odds ratio of 2.45 to get infected with the microbes of the previous occupant of their room**

PREVENTABLE

* https://www.ecdc.europa.eu/en/healthcare-associated-infections
** Risk of organism acquisition from prior room occupant -Mitchell et al Inf dis Health 2023

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Transmission through hospital environment

- Mean length of stay 6 days **
- One *Klebsiella pneumonia* in a room could infect up to 100 new patients
- Cleaning &disinfection is important weapon against AMR and HAI
-

Micro-organism **	Survival time
Staphylococcus aureus	<1min- 318 days
Klebsiella pneumoniae	0.57 – 600 days
Pseudomonas spp.	0.08 – 7 days

**Radboudumc 2022

**Porter et al- J. Hosp. Inf. 2024 https://doi.org/10.1016/j.jhin.2024.01.023

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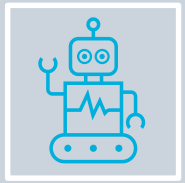
Cleaning & disinfection is our weapon against AMR

Manual mechanical cleaning and disinfection:

- Labour intensive
- Physically demanding
- Error prone
- Quality may vary during the day

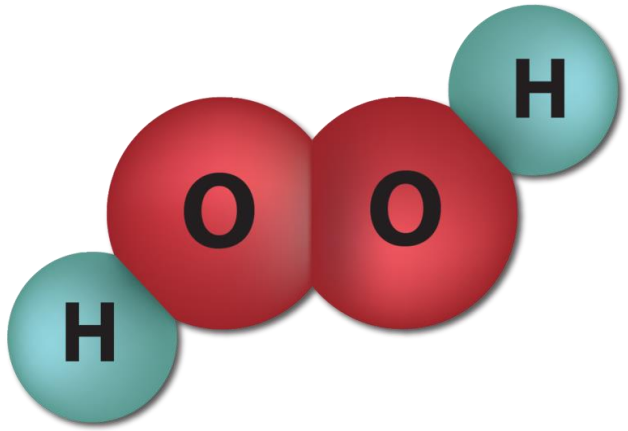


Automated whole room disinfection,

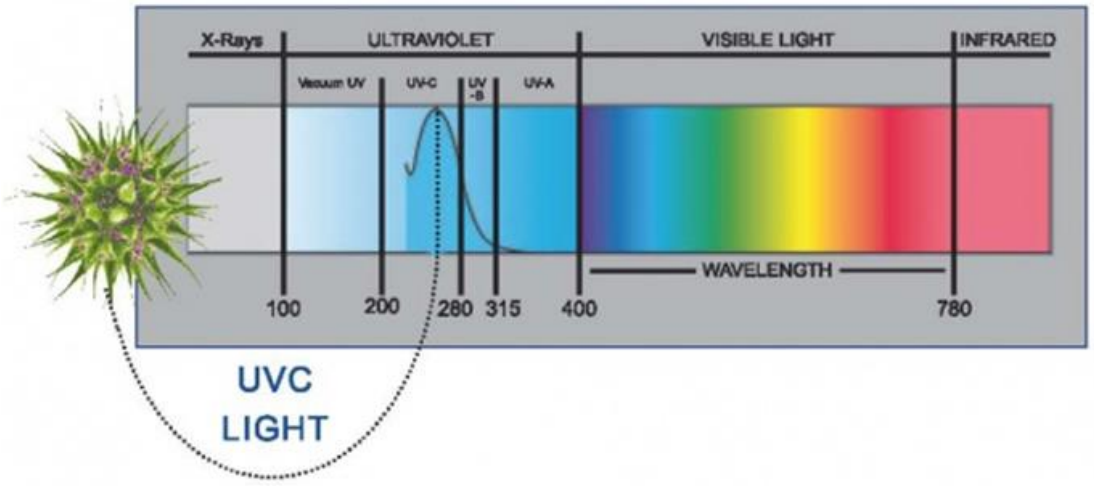
after manual cleaning, ensures a constant quality

What? Automated whole room disinfection

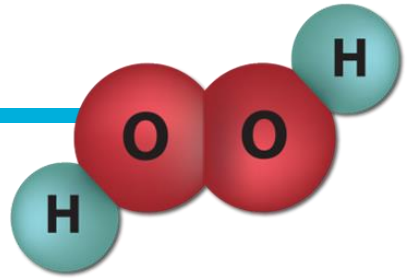
- Hydrogen peroxide (H_2O_2)



- Ultraviolet-C light



How does it work? Hydrogen peroxide



- H_2O_2 → H_2O + O-.
- O^- (oxigen radicals) kill bacteria
- Degrades into water and oxygen

  → environementally friendly
- H_2O_2 is **toxic**: No people in the room!
- Room needs to be prepared for adequate concentration
- Two methods: Aerosolised H_2O_2 and H_2O_2Vapor

Aerosolised HP (aHP)
5-7% H2O2

HP vapor (HPV)
30-35% H2O2

How does it work? aerosolised HP (aHP)

- **5-7%** H_2O_2 is fogged into the room → "dry mist"
- Room must be cleaned manually
- Literature suggests that the airvents and doors be sealed to prevent leakage of H_2O_2.
- Turn off the smoke alarm.
- Open the cupboard doors and drawers, make sure the "mist" can reach the back side of the matrass etc.
- **Measure the concentration (ppm with datalogger)**
- Room can only be re-entered when [H_2O_2] is < 1ppm. (average 2-3 hours)

Aerosolised HP (aHP)
5-7% H2O2

In vitro efficacy - aerosolised HP (aHP) review

Table 2 In vitro efficacy of aHP for the preselected set of micro-organisms, expressed in log-reduction

	Micro-organism	Effect in log_{10} reduction, median (range)	N (ref)
Viruses	Norovirus	2.5 (0.5–2.7)	3 [12, 18, 19]
	(Surrogate)	4.5 (>4–5.3)	3 [18–20]
Bacteria	*Acinetobacter*	2 (1–>4)	2 [12, 16]
	CPE		
	VRE	1–1.7	1 [21]
	ESBL	>6	1 [14]
	MRSA	>4 (2–>6)	4 [12, 14, 16, 17]
Spores	*C. difficile*	4.9 (0.13–>5)	4 [12, 14, 22, 23]
Yeast	*C. auris*		

Disinfection is:
≥ 5log reduction in bacterial load

Aerosolised HP (aHP)
5-7% H2O2

van der Starre et al. Antimicrobial Resistance & Infection Control (2022)

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Pittfalls, Pro's and Con's – aerosolised HP (aHP)

Pitfalls:

- PPM needs to be monitored during the process
- H_2O_2 particles are affected by gravity.

Pro's

- User friendly, easy to transport
- Curtains can stay in the room, they are disinfected.

Con's

- Room needs to prepared.
- Room cannot be entered for 2-3 hours
- Doesn't reach log 5 reduction

Aerosolised HP (aHP)
5-7% H2O2

van der Starre et al. Antimicrobial Resistance & Infection Control (2022)

How does it work? HP Vapor

- **30-35% H_2O_2 evaporation** (heat and multiple nozzles)
- Room must be cleaned and prepared
- Time and labour intensive preparation.
- Vents and doors *must* be sealed to prevent leaking of H_2O_2.
- Must be operated by well trained person
- Thorough validation process

In vitro efficacy - HP Vapour review

Table 4 In vitro efficacy of H_2O_2 vapour for the preselected set of micro-organisms, expressed in log-reduction

	Micro-organism	Effect in log_{10} reduction, median (range)	N (ref)
Viruses	NoV	>4	1 [18]
	(Surrogaat)	4.4 (3–≥6)	4 [33, 34, 42, 43]
Bacteria	*Acinetobacter*	>5 (>4–>6)	5 [12, 14, 35, 44, 45]
	CPE	>6	2 [44, 45]
	VRE	>6 (>4–>6)	3 [35, 44, 45]
	ESBL		
	MRSA	>6 (3–>6)	7 [12, 14, 35, 44, 46, 47]
Spores	*C. difficile*	>6 (>5,7–>6)	6 [12, 23, 31, 37, 44, 48]
Yeasts	*C. auris*		

- HP vapour effectively reduces norovirus and the preselected set of bacteria.

van der Starre et al. Antimicrobial Resistance & Infection Control (2022)

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Pittfalls, Pro's and Con's – aerosolised HP

Pitfalls:

- Needs thorough validation process .
- Check compatibility of equipment with H_2O_2.

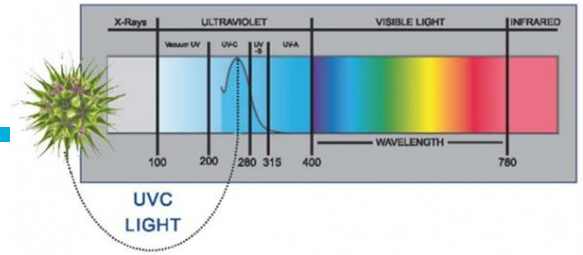
Pro's

- Good in vitro efficacy

Con's

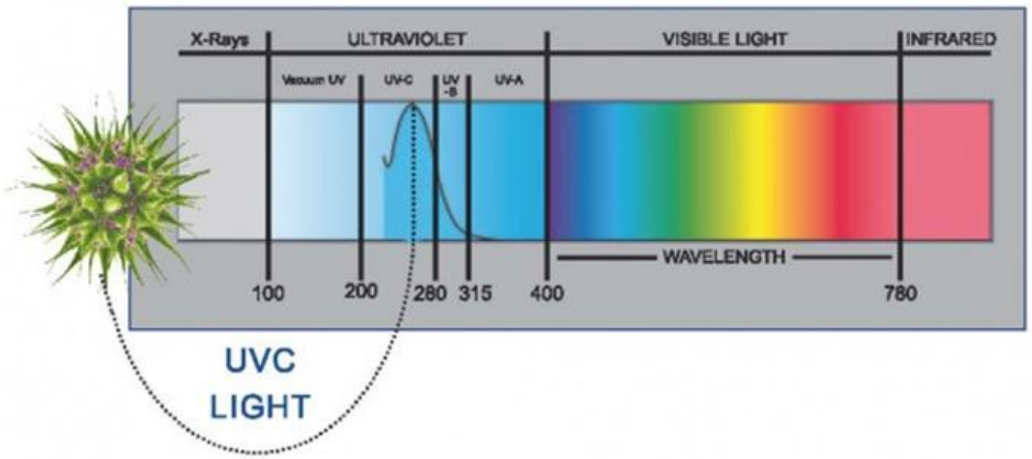
- Needs intensive training
- Preparation and vaporing is time consuming

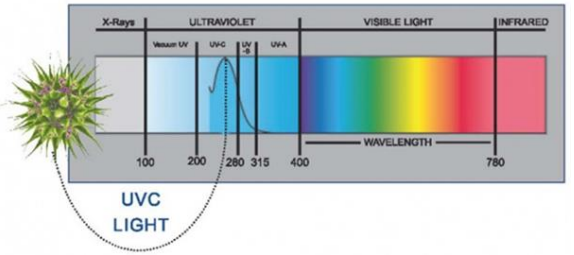
HP vapor (HPV)



How does it work? Ultraviolet C light (UV-C)

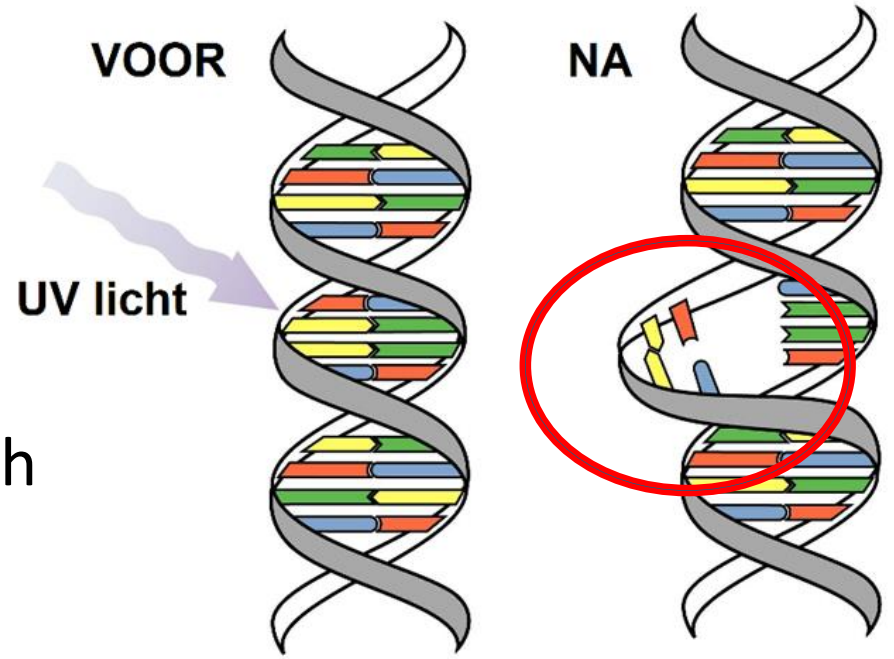
- Ultraviolet C light
  - stationary or mobile



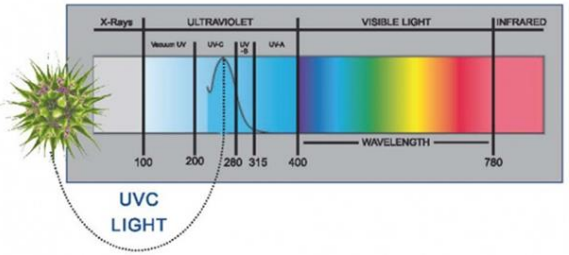


How does it work? UV-C

- UV-C has a wavelength of 254 nm
- UV-C light damages DNA/RNA →disrupts cell-division of micro-organisms
- Two thymines next to each other are linked to each other by UV-C.



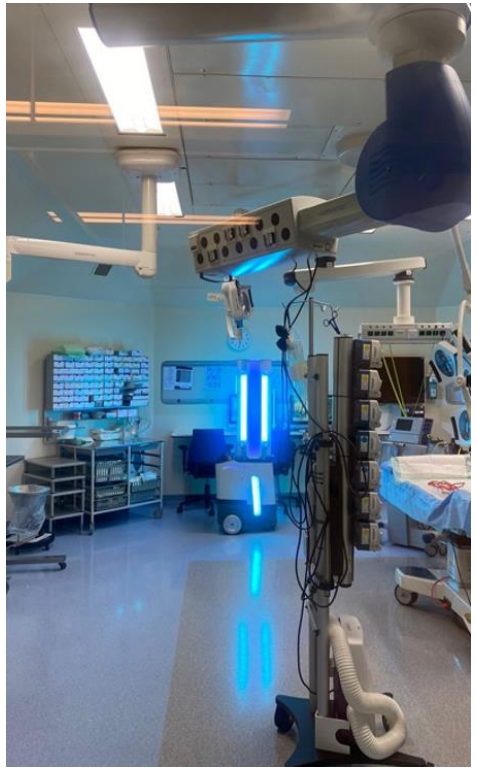
Source: INFO UV | Safety Science



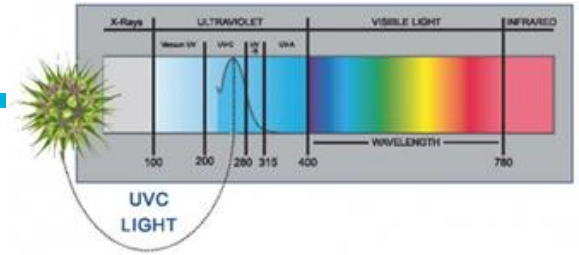
How does it work? UV-C

- Stationary and mobile systems.
- Clean before disinfection with UV-C
- Disinfection time: stationary +/- 40-50 min, mobile +/- 15-20 min
- Mobile: needs space to drive around
- Room is immediately accessible after disinfection.
- Needs validation:

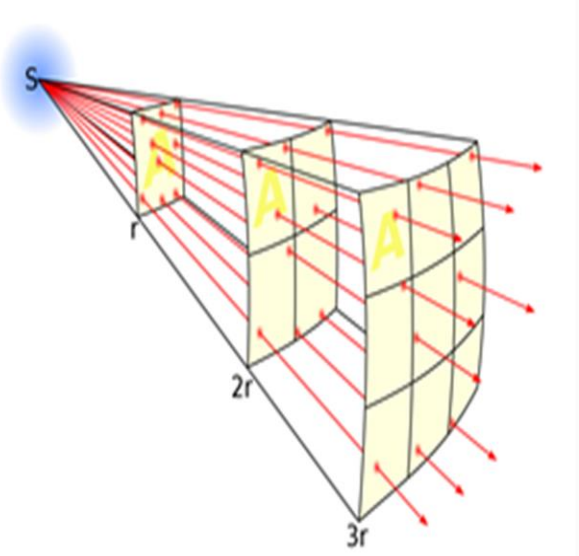
Shadow places must be disinfected manually

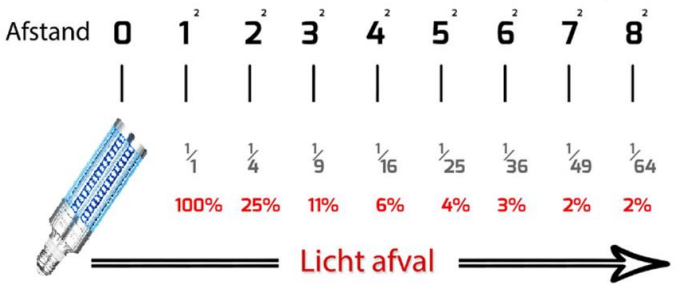


Intensity of UV-c depends on:

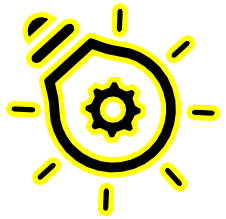


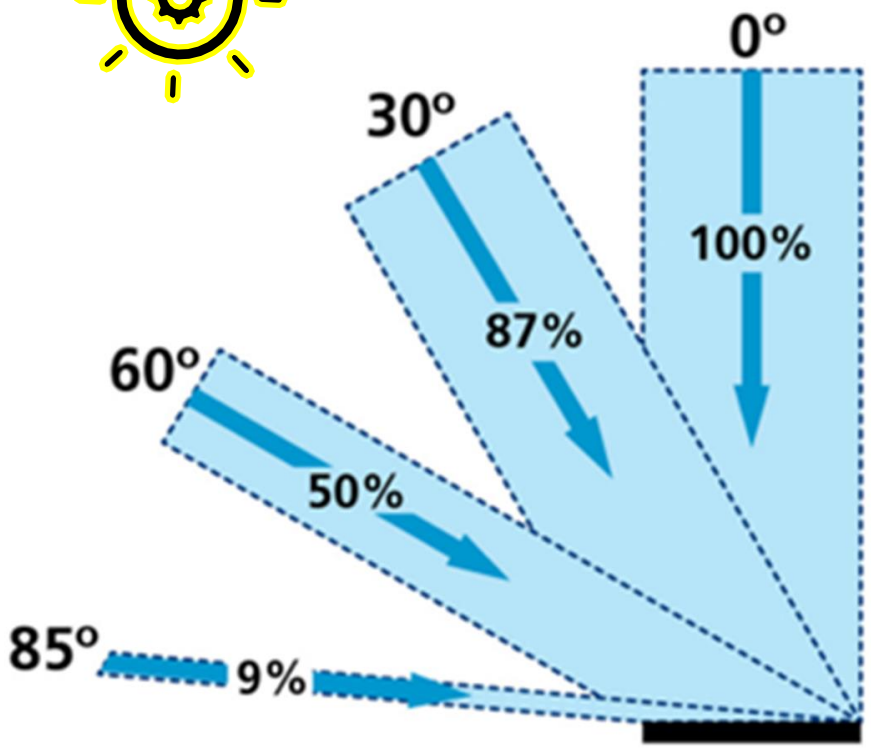
Distance



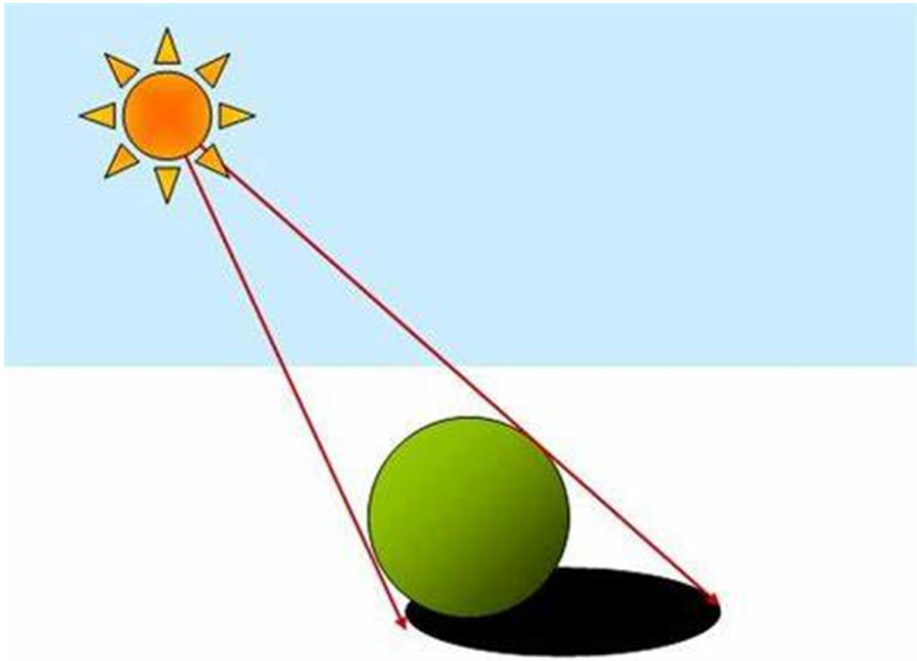


Angle





Shadow



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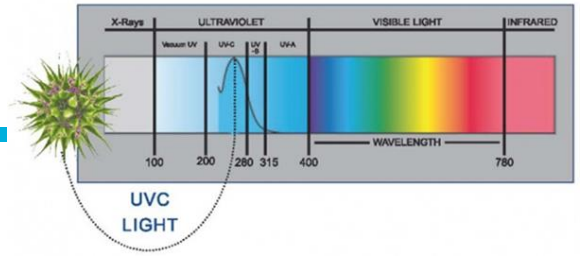

In vitro efficacy of UV-C review

Table 6 In vitro efficacy of UV-C for a preselected set of micro-organisms under optimal and suboptimal circumstances

	Micro-organism	Optimal circumstances; effect in log_{10} reduction, median (range)	Suboptimal circumstances; effect in log_{10} reduction, median (range)	N (ref)
Viruses	Norovirus			
Bacteria	*Acinetobacter*	≥ 4 (≥ 4–>8)	3 (< 1–4)	6 [58, 61–65]
	CPE	4–5	1–5	1 [66]
	ESBL	> 8	> 3	2 [62, 65]
	MRSA	4 (2–9)	< 3 (< 1–>6)	13 [58, 60–63, 65–72]
	VRE	3.9 (2–>8)	< 3 (< 1–>4)	10 [58, 60–63, 67–71]
Spores	*C. difficile*	2.5 (1–>5)	< 2 (0–>3)	11 [31, 57, 60, 61, 66–72]
Yeasts	*C. auris*	> 5 (3.99–>6)	3.3 (< 2–>4)	4 [72–75]

Big difference btwn studies and btwn optimal and suboptimal conditions

van der Starre et al. Antimicrobial Resistance & Infection Control (2022)

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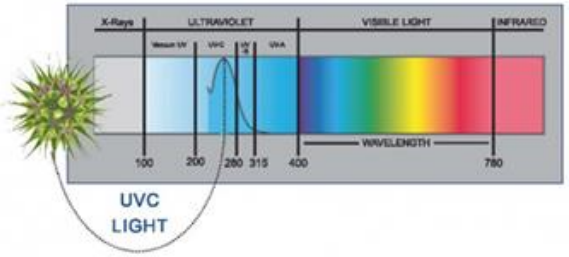
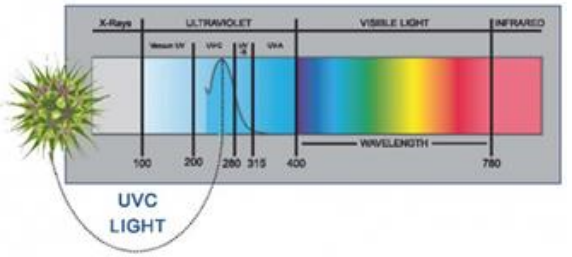
Microbiological evaluation of efficacy mobile UV-c robot in Radboudumc



- Regular patient room
- Demonstrate a log 5 reduction
- Make logarhitmic reference series for 5 relevant micro-organisms (*Escherichia coli, Staphylococcus aureus, Enterococcus faecium, Pseudomonas aeruginosa, Acinetobacter baumanni complex)*
- Inoculate Rodac-plates with bacterial suspension (0,5McFarland=log 0) and place them on various places in the patient room.
- Irradiate the plates by UV-c robot.
- Of each micro-organism a control log 0 plate was not irradiated

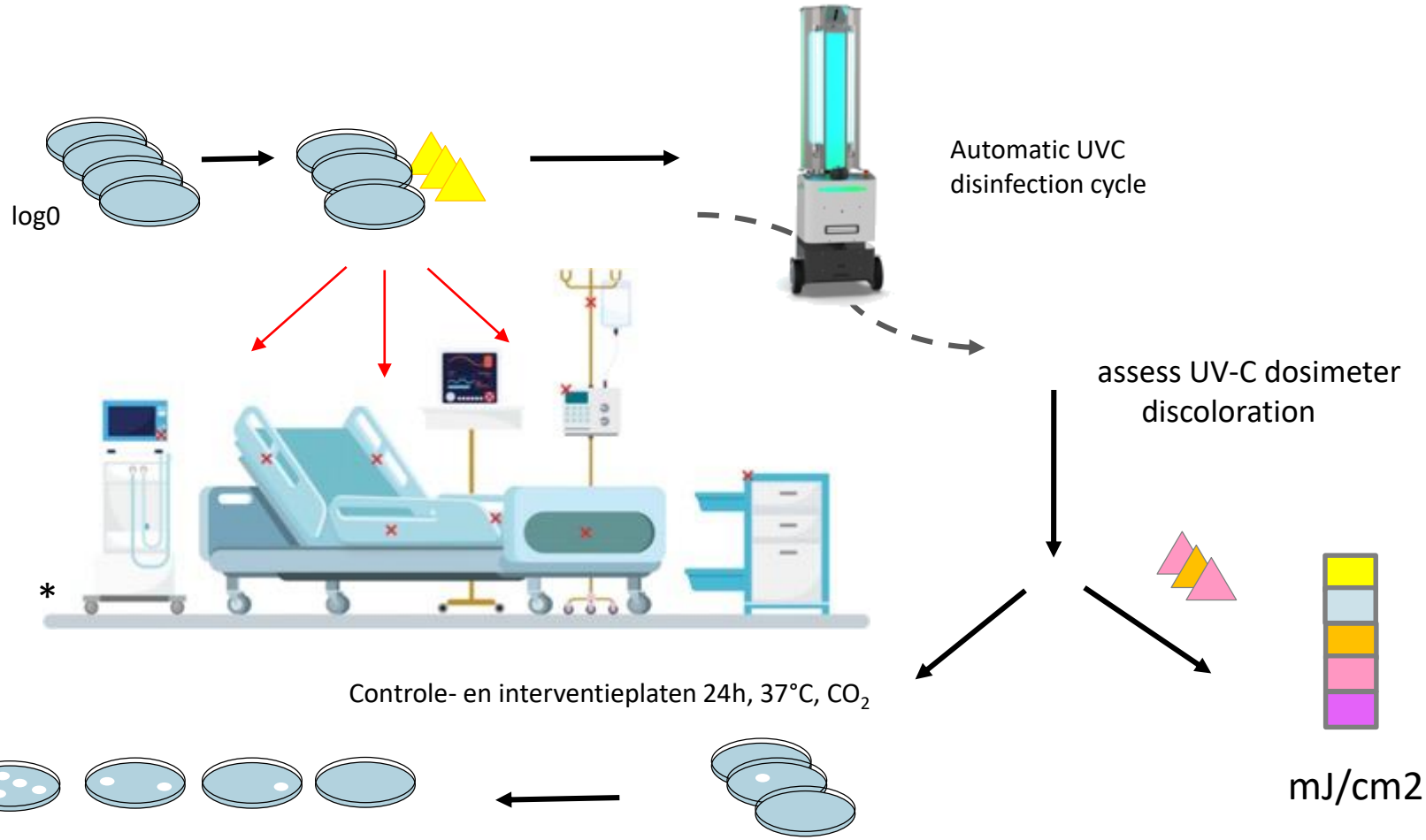
Description and results of a new method for assessing real-life performance of a UV-C disinfection robot- Rodgers et al-2023 j.infpip
https://doi.org/10.1016/j.infpip.2023.100322

Evaluation in the patient room



49 relevant positions in the patientroom, sluice and bathroom.

- Inoculated Rodacplates (log0)
- UV-C dosimeter sticker
- Horizontal & vertical placed rodac-plates and dosimeters



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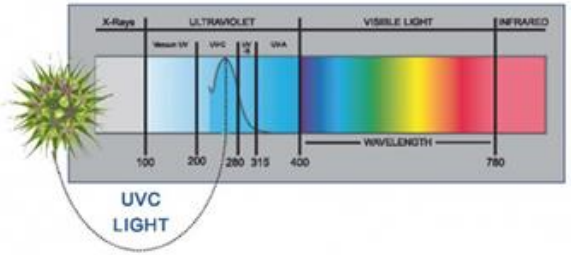
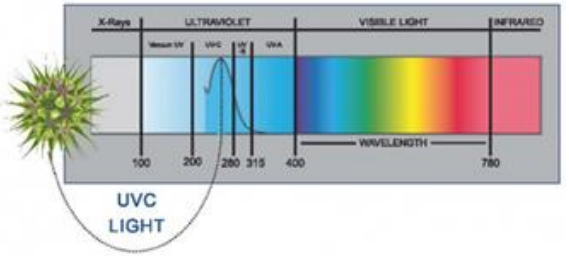


Before

After UV-C



Before

After UV-C

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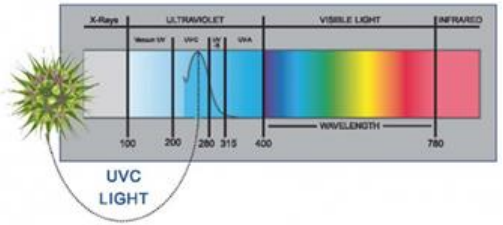
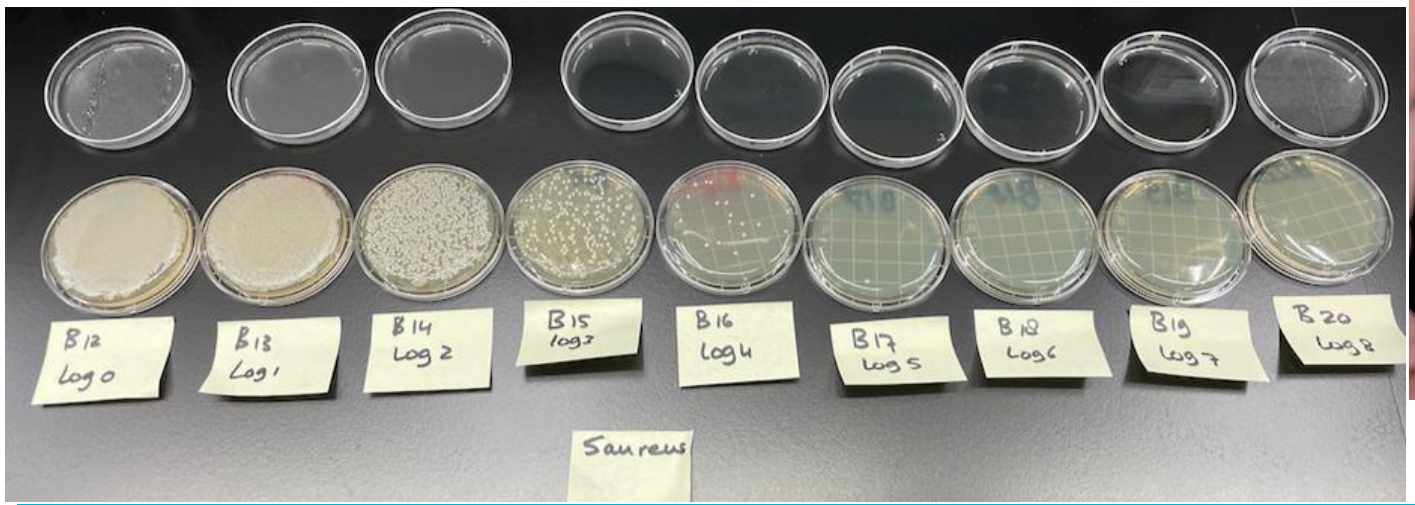
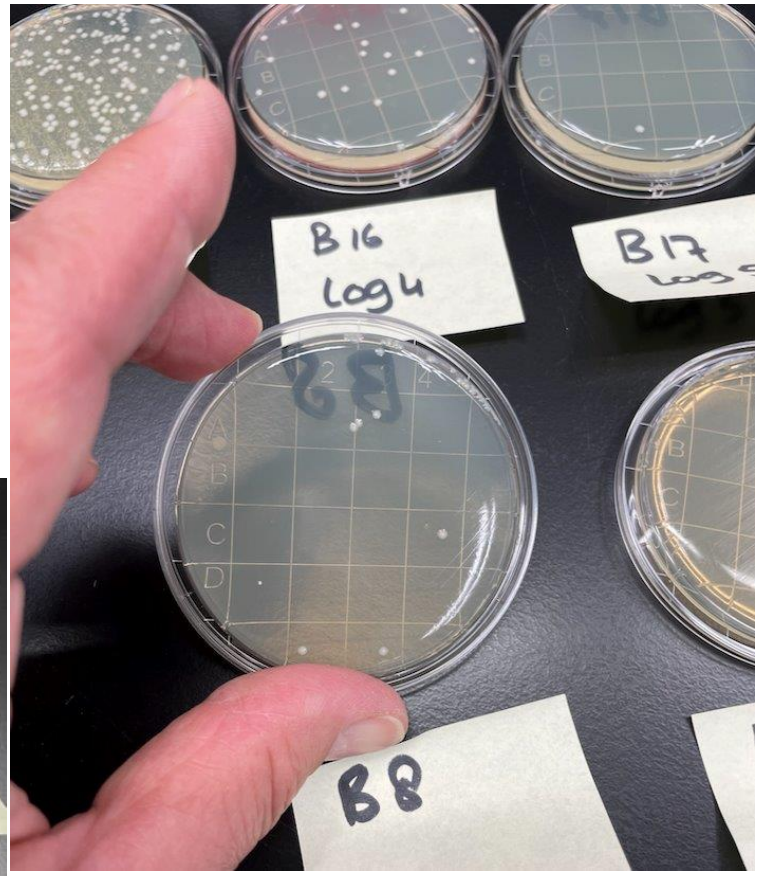


Logaritmic reference series S. aureus

Position	Micro organism	Log	Cfu's	minimal log reduction
B12	S.aureus	log 0	full	0
B13		log1	full	1
B14		log2	full	2
B15		log3	>100	3
B16		log4	23	4
B17		log5	1	5
B18		log6	1	6
B19		log7	0	7
B20		log8	0	8





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Results

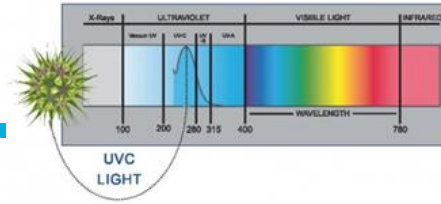

Table II

Overview of UV-C dosage received per plate, and reduction of CFU's per plate. The results are presented separately for the plates showing ≥5-log and <5-log reduction respectively. Results are split between plates placed on UV-accessible surfaces (unshaded surfaces below elbow height), and plates placed on surfaces with limited UV-accessibility ([partly] shaded and/or above elbow height)

	UV-C dosage ≥50 mJ/cm², n	UV-C dosage 25-50 mJ/cm², n	UV-C dosage 25 mJ/cm², n	UV-C dosage <25 mJ/cm², n	UV-C dosage variable or not measured, n	Total, n
UV-accessible surfaces, n	29	1	0	1	1	32
≥5-log reduction, n	28 (1 plate contaminated)	1	0	1	1	31
<5-log reduction, n	0	0	0	0	0	0
surfaces with limited UV-accessibility, n	5	1	5	6	1	18
≥5-log reduction, n	4	1	4	3	1	13
<5-log reduction, n	1	0	1	3	0	5

https://doi.org/10.1016/j.infpip.2023.100322

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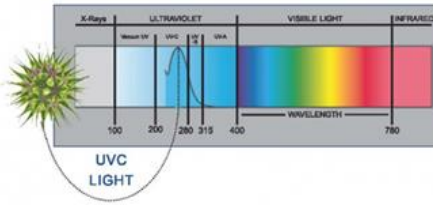

Pro's

- Adequate log reduction
- Standardised disinfection, constant predictable quality
- For the cleaning staff: less repetitive movements, less physically strenuous
- Less/no chemicals -> Environmentally friendly
- Less sickleave

Con's

- Investment
- Needs validation in a new setting.
- Training of staff
- Beware of the shadow!!
- Beds create shadow
- Check compatibility with (medical) equipment

UV-c robot does not:

- Clean the room
- Disinfect objects in the shadow
- Disinfect inside cupboards, wet surfaces

Take home message:

- Manual cleaning is essential prior to disinfection, even with automated disinfection systems.
- Every new system needs to be validated and monitored.
- Adequately executed UV-C disinfection ensures consistent disinfection quality.
- Beware of the shadow!

Questions?