

INFECTION PREVENTION

A close-up photograph of a person's hand wearing a white nitrile glove. The hand is holding a glass petri dish and using a sterile swab to streak a bacterial culture. The culture is visible as a series of white, fuzzy streaks on the agar surface. The petri dish has some faint, mirrored text on its lid, which appears to be 'PLATE COUNT', 'B: 96280', 'E: 018-03', and '11:45'.

Who is smuggling arms in your hospital?

The effectiveness of design related to hygiene control.
A quantified analysis of bedside mounting solutions.

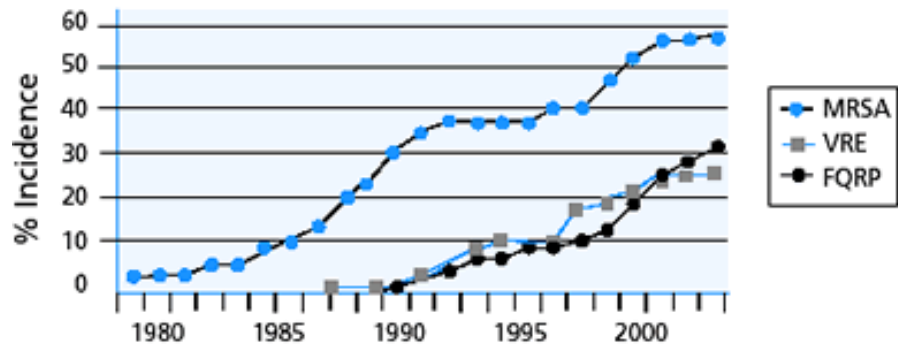
- Hospital acquired infections (HAIs) are infections that are acquired by patients in a hospital or other health-care facilities.
- HAI affect – depending on the clinical intervention – approx. 3.5 - 12%
 - 4.131.000 cases / year in Europe (prevalence 7.1%)
 - 1.700.000 cases /year in US (prevalence 4.5%)
- HAI associated deaths:
 - 37.000 patients / year in Europe
 - 99.000 patients /year in US
- Infected patients in intensive care units can be as high as 51% – most of these are health care associated.
- Approximately 30% of patients in ICUs are affected by HAIs.

- Hospital acquired infections have severe side effects:
 - Prolonged hospital stays and treatment:
 - 16 million extra days of hospital stay in Europe
 - Increased costs for treatment and medication.
 - Massive additional financial burden for health systems:
 - 7 BN € in Europe (direct costs only)
 - 9.8 BN USD in US
 - Increased mortality and unnecessary deaths:
 - 37.000 patients / year in Europe
 - 99.000 patients /year in US
 - Frequent use of antibiotics leads to increased antibiotic resistance.

BACKGROUND INFORMATION | VIEW IN THE FUTURE

- Increase of antibiotic multi-resistant microorganisms.
- According to the WHO, the number of HAI-infection associated deaths will increase to 10 million by 2050.
- This is 1.8 million more deaths than those attributed to cancer.

Resistant Strains Spread Rapidly



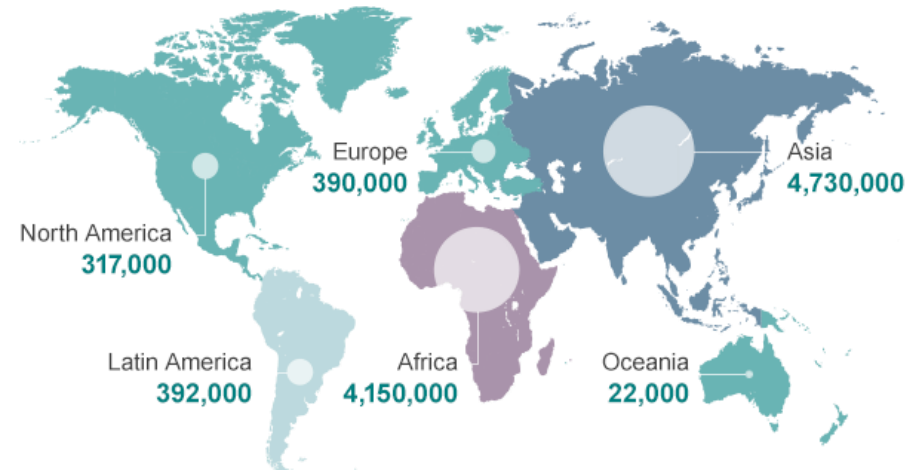
Source: Centers for Disease Control and Prevention

MRSA = Methicillin-resistant *Staphylococcus Aureus*

VRE = Vancomycin-resistant *Enterococci*

FQRP = Fluoroquinolone-resistant *Pseudomonas aeruginosa*

Deaths attributable to antimicrobial resistance every year by 2050



Source: Review on Antimicrobial Resistance 2014

Major HAI-associated pathogens:

- Staphylococcus epidermidis
- Staphylococcus aureus
- Klebsiella pneumoniae
- Pseudomonas aeruginosa
- Enterococcus faecalis
- Candida albicans



These organisms originate from:

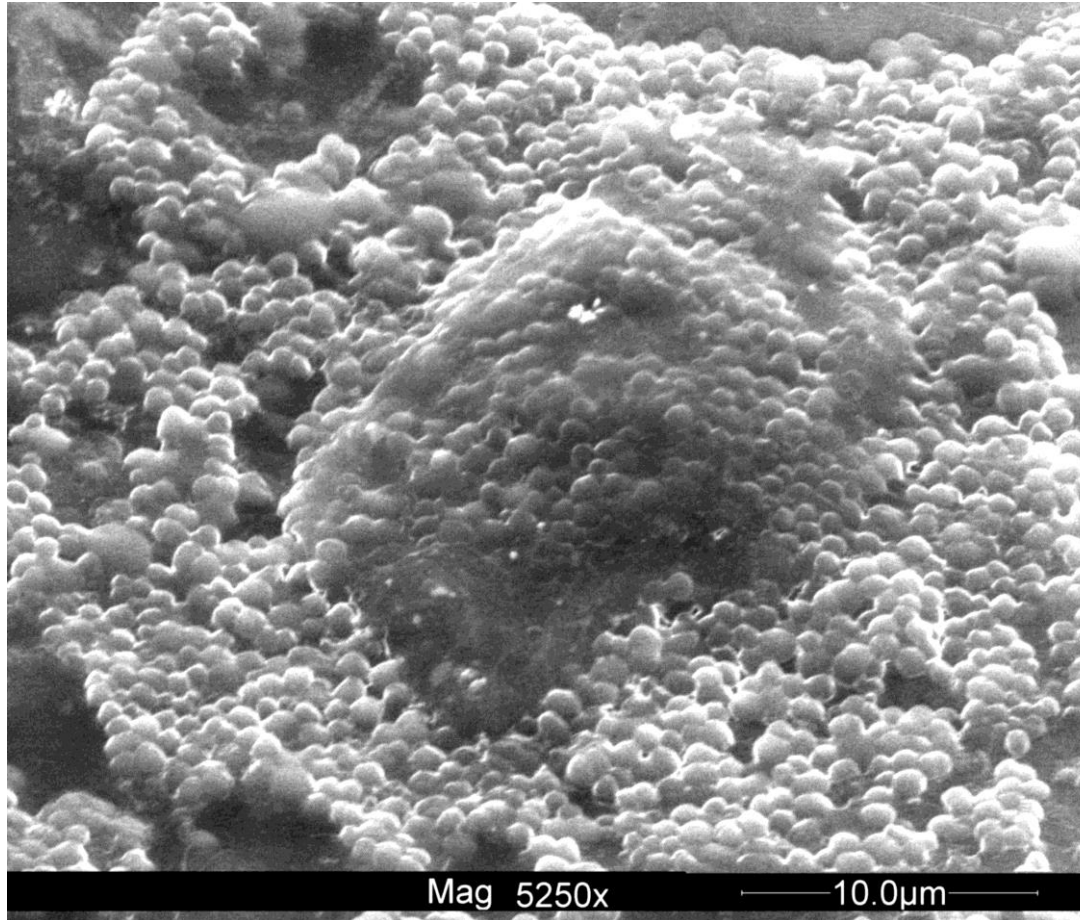
- Patient's skin microflora
- Exogenous microflora from health-care personnel
- Contaminated devices and infusates

CONTAMINATED SURFACES | MICROBIAL SURVIVAL ON DEVICES

Type of Microorganism	Microorganism	Survival period
Bacteria	Escherichia coli	Up to 16 months
	Pseudomonas aeruginosa	On dry surfaces: Up to 5 weeks In humid environment: Up to 16 months
	Staphylococcus aureus (incl. MRSA)	Up to 4 months
Mycobacteria	Mycobacterium tuberculosis	Up to 4 months
Yeast	Candida albicans	Up to 4 months

CONTAMINATED SURFACES | MICROBIAL BIOFILM ON DEVICE SURFACE

Biofilm of **Staphylococcus aureus** and **Pseudomonas aeruginosa** on a device surface after 48hrs.



MICROBIAL CONTAMINATION & HYGIENE CONTROL

Major pathways of infection transmission are:

- Hands are the main transmitters of microorganisms from Patient to patient or healthcare staff
- Contaminated surfaces



Hygiene regimens and effective cleaning of device surfaces is a crucial requirement to minimize the risk of bacteria transmission.



- Hygiene control is primarily focused on:
 - Medical devices and implants
 - Compliance with hygiene regimes
- Supportive device equipment is often not in the focus of microbial control. Investment is often initiated by cost centers without consideration of hygienic and medical needs.

Observation

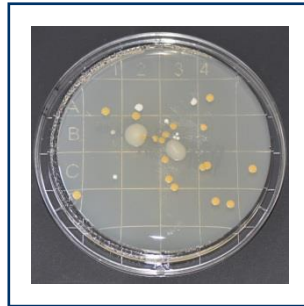
Device equipment is often neglected in the consideration of hygiene and microbial control, although commonly used in hygiene-sensitive areas.

- Mounting arms are commonly used devices in hygiene sensitive areas such as operating rooms and intensive care units (ICUs).
- Mounting arms are often used and handled during surgery, bedside monitoring and shift change.
- Hygiene control is routinely performed by wipe disinfection.
- Specific properties of mounting arm systems:
 - Attached cables to support connected devices, e.g. monitors and technical equipment.
 - Complex geometries (e.g. hinges, cable ducts, handles) due to 3-dimensional adjustment of the mounting arm.

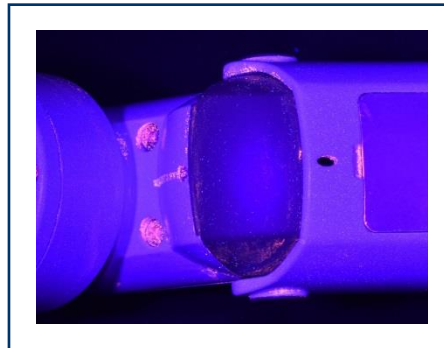
- Guidelines for clinical hygiene of medical device surfaces recommend:
 - Smooth and easy to wipe
 - Easy to clean and disinfect, especially on contact sides
 - Resistant to disinfectant agents and recommended residence times
 - Jointless, were applicable

OBJECTIVE | HYGIENE CONTROL OF MOUNTING ARM SYSTEMS

1. Effectiveness of wipe disinfection of mounting arm systems after controlled microbial contamination.












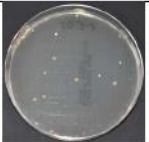



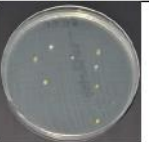





















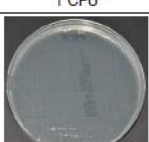
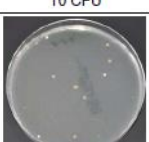
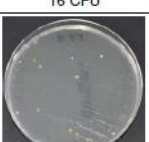
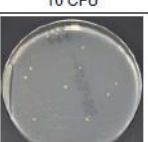
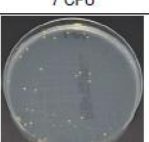


2. Visualisation of critical structures by black light color.



Test Procedure

- 7 different commercially available mounting arm systems were tested in this investigation.
- The mounting arms were placed in an aerosol chamber.
- The mounting arms were contaminated by aerosol nebulization with a microbial mixture consisting of clinically relevant pathogens:
Staphylococcus aureus (Gram-positive), **Escherichia coli** (Gram-negative) and **Candida albicans** (yeast).
A defined contamination of approx. 10 CFU/cm² was applied.
- After the contamination, the surfaces were disinfected by wipe disinfection, which is the recommended cleaning method.
- Over a period of 8 hrs microbial contamination was investigated.
- Sterile swabs were used to recover bacteria from critical and complex geometries, such as hinges, joints, cable ducts and edges between construction components.

RESULTS | EFFECTIVENESS OF WIPE DISINFECTION

Time	CIM med	GCX1	GCX2	Ergotron	Amico	Cleanmount	ITD
0	 1 CFU	 15 CFU	 15 CFU	 10 CFU	 10 CFU	 22 CFU	 8 CFU
0.5	 5 CFU	 15 CFU	 13 CFU	 12 CFU	 25 CFU	 21 CFU	 8 CFU
1	 4 CFU	 14 CFU	 14 CFU	 13 CFU	 27 CFU	 20 CFU	 9 CFU
2	 3 CFU	 13 CFU	 14 CFU	 15 CFU	 62 CFU	 20 CFU	 14 CFU
4	 1 CFU	 10 CFU	 16 CFU	 10 CFU	 7 CFU	 19 CFU	 9 CFU
8	 0 CFU	 10 CFU	 11 CFU	 10 CFU	 33 CFU	 17 CFU	 10 CFU

RESULTS | EFFECTIVENESS OF WIPE DISINFECTION

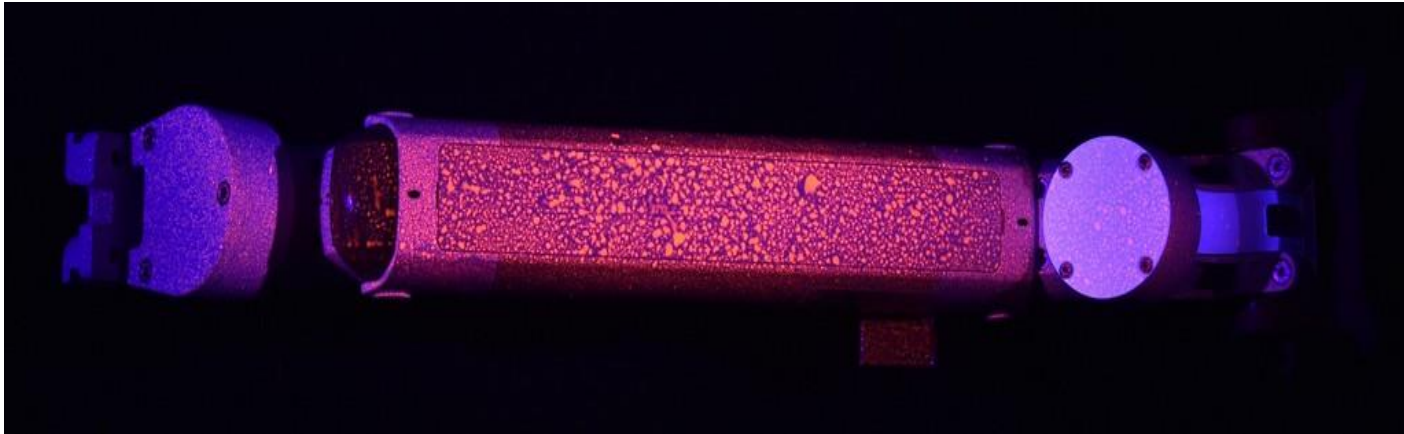
Sample	Average CFU/sample	Normalization to HV Arm with lowest CFU	Difference factor
HV Arm CIM med	2,3	100%	1,0
HV Arm GCX 1	12,8	550,0%	5,5
HV Arm GCX 2	13,8	592,9%	5,9
HV Arm Ergotron	11,7	500,0%	5,0
HV Arm Amico	27,3	1171,4%	11,7
HV Arm CleanMount	19,8	850,0%	8,5
HV Arm ITD	9,7	414,3%	4,1

1. A wipe disinfection can efficiently reduce the number of bacteria on mounting arm surfaces.
2. Bacterial contamination was found on all tested mounting arms, especially on complex geometries, such as hinges, external cable ducts and crevasses after disinfection.
3. Complex geometries, such as hinges and external cable ducts, are hard to disinfect by wipe disinfection and comprise the risk of bacterial contamination and transmission during handling.
4. In this investigation, the HV mounting ARM CIM showed the lowest number of bacteria due to the internal cable duct and smooth surface and small crevasses.

Test Procedure

- 7 different commercially available mounting arm systems were tested in this investigation.
- The mounting arms were “contaminated” aerosol nebulization of a pink black light colour (approx. 0.5ml per system).
- The black light colour was dried for 1 hr.
- The surfaces were carefully disinfected by wipe disinfection, which is the recommended cleaning method.
- The mounting arm systems were analyzed and photographed under UV-light for remaining traces of black light colour, which was not removed by the wipe disinfection procedure.

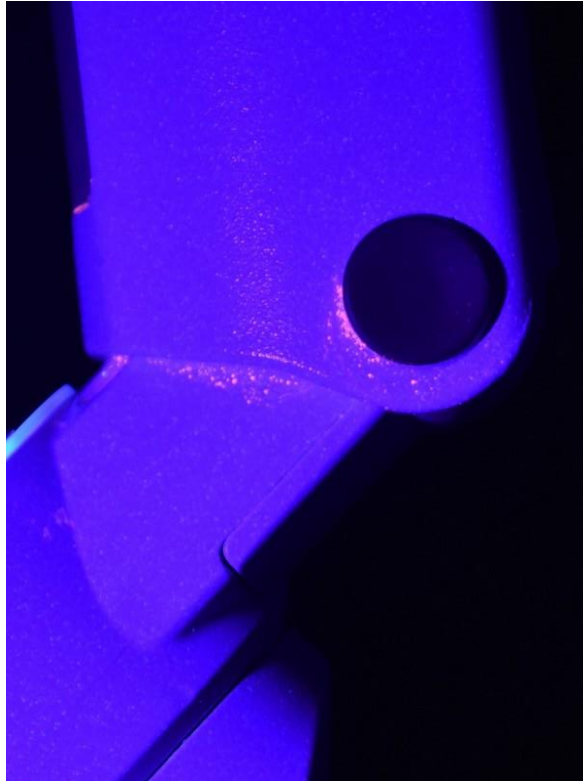
Mounting arm after „contamination“



Mounting arm after wipe disinfection



Close-up of hinge after disinfection



Close-up of hinge 2 after disinfection

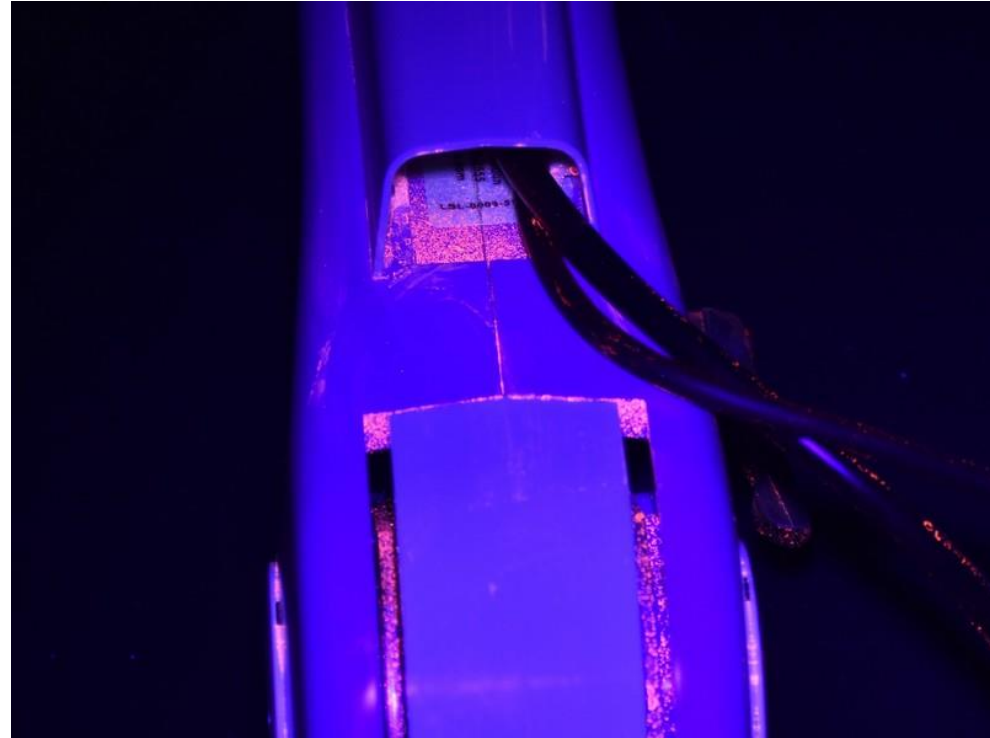


RESULTS BLACK LIGHT COLOUR | MOUNTING ARM GCX1

Close-up of hinge after disinfection

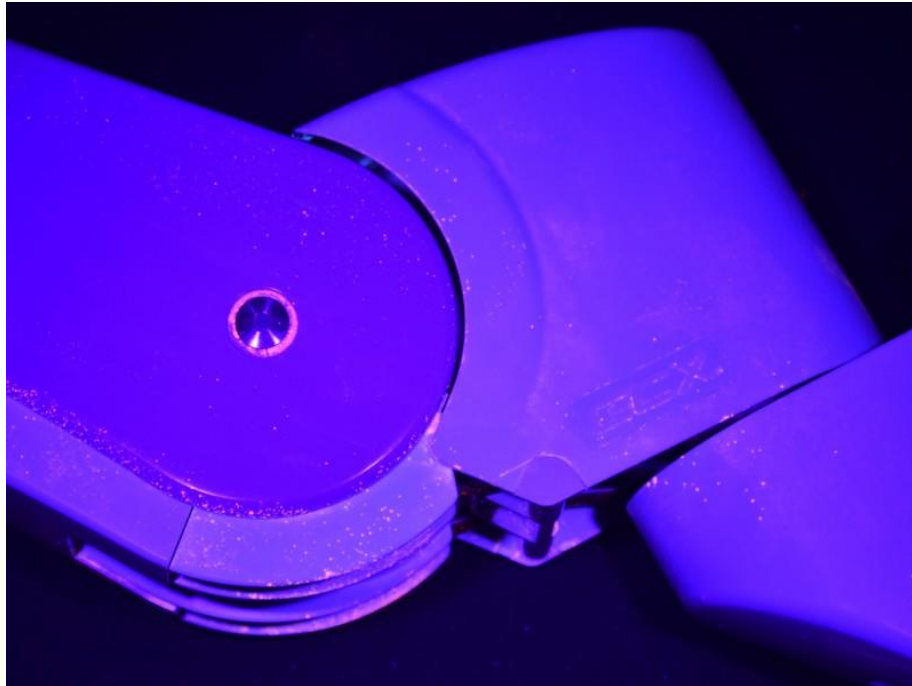


Close-up of cable duct after disinfection

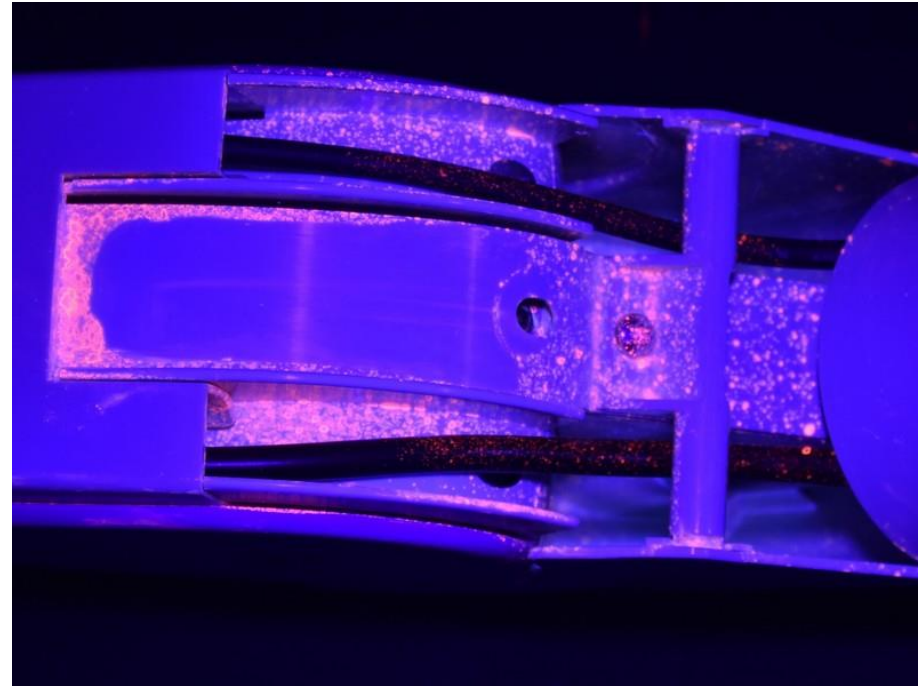


RESULTS BLACK LIGHT COLOUR | MOUNTING ARM GCX2

Close-up of hinge after disinfection



Close-up of cable duct after disinfection

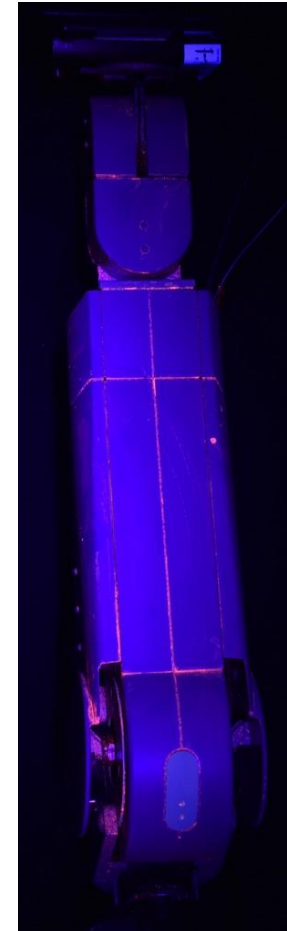


RESULTS BLACK LIGHT COLOUR | MOUNTING ARM ERGOTRON

Close-up of hinge after disinfection



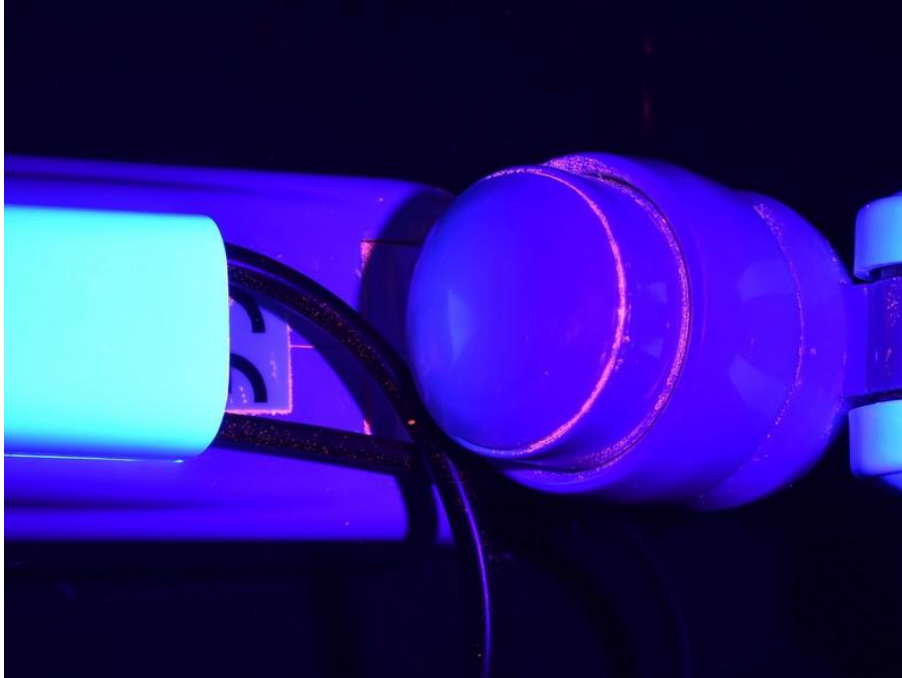
Close-up of bottom side after disinfection



RESULTS BLACK LIGHT COLOUR

MOUNTING ARM AMICO

Close-up of hinge after disinfection



Close-up of cable duct after disinfection



RESULTS BLACK LIGHT COLOUR | MOUNTING ARM CLEANMOUNT

Close-up of hinge after disinfection

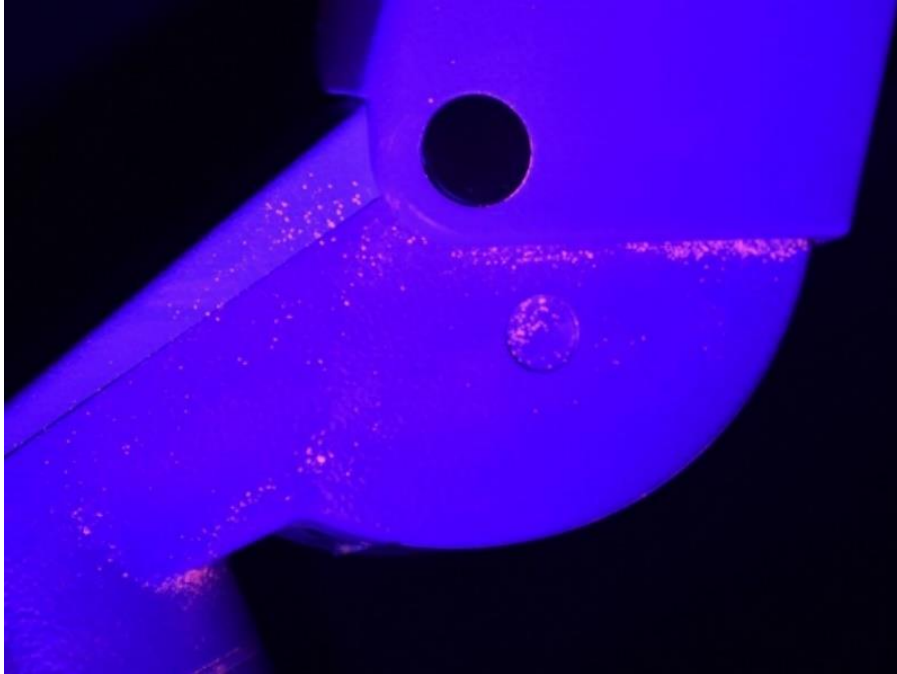


Close-up of cable outlet after disinfection

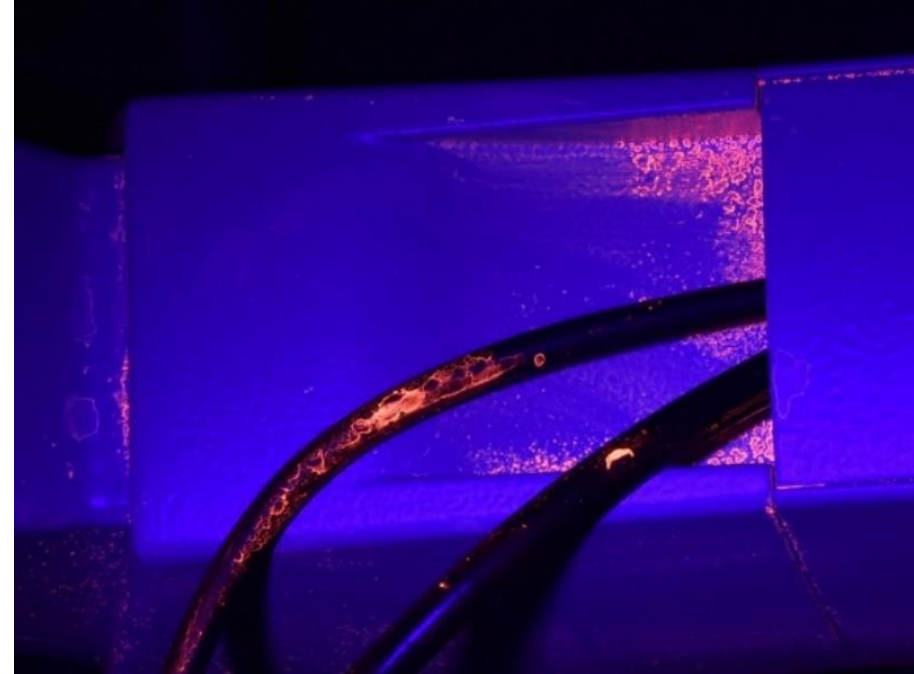


RESULTS BLACK LIGHT COLOUR | MOUNTING ARM ITD

Close-up of hinge after disinfection



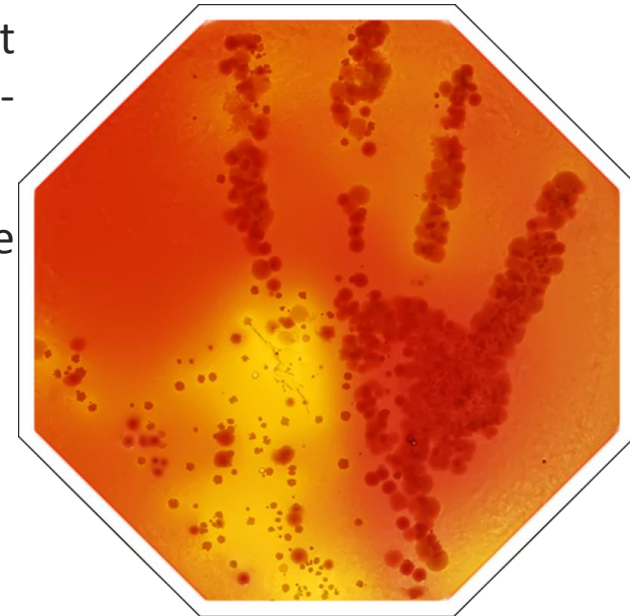
Close-up of cable duct after disinfection



- The results demonstrate that clean, smooth and plain surfaces can be efficiently cleaned by wipe disinfection.
- All structured surfaces or complex 3-dimensional components, such as hinges, external cable ducts, inlets and outlets of cable ducts can be hardly disinfected by wipe disinfection, which is the recommended cleaning procedure.
- Internal cable ducts proofed to be of advantage, because especially cable duct inlets and outlets showed significant traces of black light color after careful wipe disinfection (comprising a risk of bacterial contamination, which is not eliminated by normal wipe disinfection in daily clinical hygiene).
- By applying the presented test procedure the HV mounting ARM CIM showed the lowest levels of black light of all tested mounting arm used in this study. This results was due to the internal cable duct and less structured surfaces, which allows a more effective wipe disinfection of the arm surface.
- The construction of the arms is an essential key for efficient superficial disinfection cleaning.

OUTLOOK

- The construction of the arms is an essential key for efficient superficial disinfection cleaning.
- Clean, smooth and plain surfaces can be efficiently cleaned by wipe disinfection, whereas structured surfaces comprise the risk to harbor microbial contamination.
- Efficient disinfection helps to prevent to transmit pathogens from medical devices as source of hospital-acquired infections.
- The choice of appropriate equipment supports hygiene control especially in hygiene-sensitive areas.



THANK YOU FOR YOUR ATTENTION

MTC

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