INFECTION PREVENTION
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.
• 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.
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
## Microbial Survival on Devices

<table>
<thead>
<tr>
<th>Type of Microorganism</th>
<th>Microorganism</th>
<th>Survival period</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bacteria</strong></td>
<td>Escherichia coli</td>
<td>Up to 16 months</td>
</tr>
<tr>
<td></td>
<td>Pseudomonas aeruginosa</td>
<td>On dry surfaces: Up to 5 weeks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>In humid environment: Up to 16 months</td>
</tr>
<tr>
<td></td>
<td>Staphylococcus aureus (incl. MRSA)</td>
<td>Up to 4 months</td>
</tr>
<tr>
<td><strong>Mycobacteria</strong></td>
<td>Mycobacterium tuberculosis</td>
<td>Up to 4 months</td>
</tr>
<tr>
<td><strong>Yeast</strong></td>
<td>Candida albicans</td>
<td>Up to 4 months</td>
</tr>
</tbody>
</table>
Biofilm of *Staphylococcus aureus* and *Pseudomonas aeruginosa* on a device surface after 48hrs.
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
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

<table>
<thead>
<tr>
<th>Time</th>
<th>CIM med</th>
<th>GCX1</th>
<th>GCX2</th>
<th>Ergotron</th>
<th>Amico</th>
<th>Cleanmount</th>
<th>ITD</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1 CFU</td>
<td>15 CFU</td>
<td>15 CFU</td>
<td>10 CFU</td>
<td>10 CFU</td>
<td>22 CFU</td>
<td>8 CFU</td>
</tr>
<tr>
<td>0.5</td>
<td>5 CFU</td>
<td>15 CFU</td>
<td>13 CFU</td>
<td>12 CFU</td>
<td>25 CFU</td>
<td>21 CFU</td>
<td>8 CFU</td>
</tr>
<tr>
<td>1</td>
<td>4 CFU</td>
<td>14 CFU</td>
<td>14 CFU</td>
<td>13 CFU</td>
<td>27 CFU</td>
<td>20 CFU</td>
<td>9 CFU</td>
</tr>
<tr>
<td>2</td>
<td>3 CFU</td>
<td>13 CFU</td>
<td>14 CFU</td>
<td>15 CFU</td>
<td>62 CFU</td>
<td>20 CFU</td>
<td>14 CFU</td>
</tr>
<tr>
<td>4</td>
<td>1 CFU</td>
<td>10 CFU</td>
<td>16 CFU</td>
<td>10 CFU</td>
<td>7 CFU</td>
<td>19 CFU</td>
<td>9 CFU</td>
</tr>
<tr>
<td>8</td>
<td>0 CFU</td>
<td>10 CFU</td>
<td>11 CFU</td>
<td>10 CFU</td>
<td>33 CFU</td>
<td>17 CFU</td>
<td>10 CFU</td>
</tr>
</tbody>
</table>
### RESULTS

#### EFFECTIVENESS OF WIPE DISINFECTION

<table>
<thead>
<tr>
<th>Sample</th>
<th>Average CFU/sample</th>
<th>Normalization to HV Arm with lowest CFU</th>
<th>Difference factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>HV Arm CIM med</td>
<td>2,3</td>
<td>100%</td>
<td>1,0</td>
</tr>
<tr>
<td>HV Arm GCX 1</td>
<td>12,8</td>
<td>550,0%</td>
<td>5,5</td>
</tr>
<tr>
<td>HV Arm GCX 2</td>
<td>13,8</td>
<td>592,9%</td>
<td>5,9</td>
</tr>
<tr>
<td>HV Arm Ergotron</td>
<td>11,7</td>
<td>500,0%</td>
<td>5,0</td>
</tr>
<tr>
<td>HV Arm Amico</td>
<td>27,3</td>
<td>1171,4%</td>
<td>11,7</td>
</tr>
<tr>
<td>HV Arm CleanMount</td>
<td>19,8</td>
<td>850,0%</td>
<td>8,5</td>
</tr>
<tr>
<td>HV Arm ITD</td>
<td>9,7</td>
<td>414,3%</td>
<td>4,1</td>
</tr>
</tbody>
</table>
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.
RESULTS BLACK LIGHT COLOUR | MOUNTING ARM CIM med

Mounting arm after „contamination“

Mounting arm after wipe disinfection
Close-up of hinge after disinfection

Close-up of hinge 2 after disinfection
Close-up of hinge after disinfection

Close-up of cable duct after disinfection
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
Close-up of hinge after disinfection

Close-up of cable duct after disinfection
Close-up of hinge after disinfection

Close-up of cable outlet after disinfection
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.
• 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.