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**SELF STUDY MODULE:**

**SOFT SURFACE  
CONTAMINATION AND HAI  
RISK**

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# LEARNING OBJECTIVES



AT THE END OF THIS STUDY MODULE, LEARNERS WILL BE ABLE TO:

1. DESCRIBE THE CONTRIBUTION OF SOFT SURFACE CONTAMINATION TO INFECTION TRANSMISSION RISK
2. PROVIDE THREE EXAMPLES OF SOFT SURFACES IN THE HEALTHCARE ENVIRONMENT
3. LIST TWO INNOVATIVE ADJUNCTS TO ENSURING SAFE, PATHOGEN FREE TEXTILES IN HEALTHCARE

# OVERVIEW OF SELF STUDY MODULE CONTENT

1. HAI (HEALTHCARE ASSOCIATED INFECTION) OVERVIEW
2. THE ROLE OF SOFT AND SOLID SURFACES CONTAMINATION IN DEVELOPMENT AND TRANSMISSION OF HAI
3. INFECTION RISK ASSOCIATED WITH SOFT SURFACES
4. EVIDENCE BASED SOLUTIONS – THE BASICS AND SUPPLEMENTAL MEASURES
5. THE FUTURE OF HOSPITAL CLEANING?
6. REFERENCES

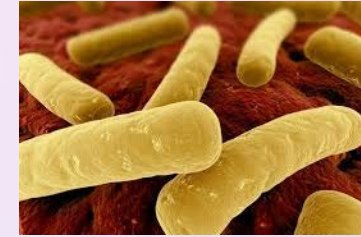


# **1. HAI OVERVIEW (HEALTHCARE ASSOCIATED INFECTION)**





# HAI OVERVIEW (HEALTHCARE ASSOCIATED INFECTION)



- THE ANNUAL INCIDENCE OF *CLOSTRIDIUM DIFFICILE* INFECTION (CDI) IN THE UNITED STATES IS ESTIMATED TO BE 500,000 CASES WITH ATTRIBUTABLE OF \$29,000 PER CASE AND MORTALITY RATE 6%–30% AND RISING<sup>1</sup>.
- *CLOSTRIDIUM DIFFICILE* OR “C. DIFF”, IS A BACTERIUM THAT CAN CAUSE SYMPTOMS RANGING FROM DIARRHEA TO LIFE-THREATENING INFLAMMATION OF THE COLON<sup>2</sup>.
- THE BACTERIA ARE FOUND IN THE FECES. PEOPLE CAN BECOME INFECTED IF THEY TOUCH ITEMS OR SURFACES THAT ARE CONTAMINATED AND THEN TOUCH THEIR MOUTH, MUCOUS MEMBRANES, FOOD OR UTENSILS<sup>2</sup>.
- HEALTHCARE WORKERS CAN SPREAD THE BACTERIA TO PATIENTS OR CONTAMINATE SURFACES THROUGH HAND CONTACT<sup>2</sup>.



## HAI OVERVIEW CONTINUED

- METHICILLIN-RESISTANT *STAPHYLOCOCCUS AUREUS* (MRSA) AND VANCOMYCIN-RESISTANT ENTEROCOCCI (VRE) CAUSE HAI AND ARE ASSOCIATED WITH INCREASED RATES OF ILLNESS AND DEATH.
- BOTH ORGANISMS ARE NOW ENDEMIC IN MANY HEALTHCARE INSTITUTIONS, PARTICULARLY IN INTENSIVE CARE UNITS (ICU)
- MRSA AND VRE ARE TRANSMITTED MOST FREQUENTLY BY DIRECT SKIN-TO-SKIN CONTACT OR CONTACT WITH SHARED ITEMS OR SURFACES (E.G., TOWELS, USED BANDAGES) THAT ARE CONTAMINATED WITH THE PATHOGEN(S). ANIMALS CAN ALSO TRANSFER THE PATHOGEN AMONG PEOPLE WHO HANDLE THEM<sup>3</sup>.





## HAI OVERVIEW CONTINUED

- A DEADLY MOLD OUTBREAK WAS IDENTIFIED IN 2014 AT UNIVERSITY OF PITTSBURGH MEDICAL CENTER HOSPITALS.
- 7 TRANSPLANT PATIENTS TO DATE HAVE DIED AFTER BEING EXPOSED TO THE MOLD. THE SOURCE HAS NOT BEEN IDENTIFIED, BUT CAUSES CONSIDERED INCLUDE CONTAMINATED LINEN, INCORRECT NEGATIVE PRESSURE IN ONE OF THE PATIENT'S ROOMS, ADJACENT CARPETED HALLWAYS.
- THE TYPE OF MOLD IDENTIFIED WAS MUCOR. OUTBREAKS OF HEALTH CARE–ASSOCIATED MUCORMYCOSIS HAVE BEEN IDENTIFIED, MOST COMMONLY IN PERSONS WITH MARKED IMMUNOSUPPRESSION, SUCH AS BONE MARROW AND SOLID ORGAN TRANSPLANT RECIPIENTS.<sup>4</sup>

## HAI OVERVIEW CONTINUED



- IN FEBRUARY 2017 WHO (WORLD HEALTH ORGANIZATION) RELEASED A LIST OF 12 TYPES OF BACTERIA THAT POSE THE GREATEST THREAT TO HUMAN HEALTH.
- THIS LIST INCLUDES ACINETOBACTER, PSEUDOMONAS AND ENTEROBACTERIACEAE, ALL OF WHICH CAN BE TRANSMITTED VIA ENVIRONMENTAL SURFACES AND CAN CAUSE DEADLY WOUND, BLOODSTREAM AND OTHER TYPES OF INFECTIONS.
- MANY OF THESE BACTERIA ARE RESISTANT TO CARBAPENEM AND CEPHALOSPORIN ANTIBIOTICS WHICH ARE THE FIRST LINE TREATMENT.<sup>5</sup>

# HAI OVERVIEW CONTINUED: ENVIRONMENTALLY TRANSMITTED PATHOGENS

- ENTERIC PATHOGENS FOUND IN THE INTESTINE, COMMONLY CONTAMINATE THE HEALTHCARE ENVIRONMENT AND CAN BE EASILY TRANSMITTED BY HANDS OR EQUIPMENT.
- ENTERIC PATHOGENS INCLUDE *CLOSTRIDIUM DIFFICILE*, *SALMONELLA*, *E. COLI*.
- OTHER PATHOGENS THAT CAN BE TRANSMITTED VIA ENVIRONMENTAL SURFACES INCLUDE MRSA, ESBL, VRE.<sup>6</sup>



## **2. THE ROLE OF SOFT AND SOLID SURFACES CONTAMINATION IN DEVELOPMENT AND TRANSMISSION OF HAI**



# ROLE OF CONTAMINATED SOLID SURFACES IN HAI RISK

- CONTAMINATED SURFACES ESPECIALLY IN THE PATIENT ZONE, HAVE BEEN IMPLICATED IN TRANSMISSION OF INFECTION.
- CURRENTLY THE MOST SIGNIFICANT PATHOGEN OF CONCERN THAT IS ENVIRONMENTALLY TRANSMITTED, IS *CLOSTRIDIUM DIFFICILE*.
- OTHER PATHOGENS TRANSMITTED VIA THE ENVIRONMENT INCLUDE MRSA, VRE AND NOROVIRUS.
- CLEANING OF PATIENT ROOMS IS OFTEN INSUFFICIENT TO ELIMINATE THESE PATHOGENS.<sup>7</sup>





# ROLE OF CONTAMINATED SOFT SURFACES IN HAI RISK

- HOSPITAL TEXTILES INCLUDING PRIVACY CURTAINS, PATIENT GOWNS AND BED LINEN HAVE BEEN IMPLICATED IN TRANSMISSION OF INFECTION.
- AEROSOLS OF MRSA AND OTHER BACTERIA CAN BE SPREAD DURING BED MAKING, WHICH MAY PLAY A ROLE IN MRSA COLONIZATION OF HEALTHCARE WORKERS AND SUBSEQUENT TRANSMISSION TO PATIENTS.<sup>8</sup>





[illegible]

- THE STANDARD PROCESS FOR HEALTHCARE ENVIRONMENTAL CLEANING IS THE MANUAL METHOD, USING ANY NUMBER OF PRODUCTS.<sup>7</sup>
- SINCE MANUAL CLEANING IS PERFORMED BY HUMANS, IT IS NEVER PERFECT, AND CONSEQUENTLY CONTAMINATION CAN REMAIN AFTER CLEANING IS COMPLETED.
- IT HAS BEEN PROVEN THAT ADMISSION TO A ROOM PREVIOUSLY OCCUPIED BY A PATIENT WITH MRSA, VRE, ACINETOBACTER, OR *C. DIFFICILE* INCREASES THE RISK FOR THE SUBSEQUENT PATIENT ADMITTED TO THE ROOM TO ACQUIRE THE PATHOGEN.<sup>7</sup>
- MANY FACILITIES ARE ADDING SUPPLEMENTAL AUTOMATED TECHNOLOGY SUCH AS UV DISINFECTION TO IMPROVE THE QUALITY OF ENVIRONMENTAL CLEANING AND THE SAFETY OF PATIENTS.<sup>6</sup>

### **3. INFECTION RISK ASSOCIATED WITH SOFT SURFACES**



# RISK OF CONTAMINATED LINEN AND LAUNDRY

- VRE (VANCOMYCIN RESISTANT ENTEROCOCCUS) STRAINS CAN SURVIVE FOR 11 WEEKS ON LINEN AND PLASTIC.
- IN ONE REPORT, OVER 200 CULTURES OF HOSPITAL LINEN AS WELL AS LINEN ROOMS AND TROLLEYS FOR TRANSPORTING LINEN WERE COLLECTED. THE MOST COMMON MICROORGANISMS WERE FOUND TO BE COAGULASE-NEGATIVE STAPHYLOCOCCI, BACILLUS SPP. AND MOLDS.
- CLEAN LINEN CAN BECOME A VECTOR FOR TRANSMISSION OF PATHOGENS, AND PATHOGENS PRESENT ON LINEN MAY BECOME AIRBORNE DURING BED-MAKING, SUBSEQUENTLY CONTAMINATING SURFACES.<sup>9,10</sup>



“Reports of survival of microorganisms on hospital textiles after laundering” taken directly from: Sabina Fijan and Sonja Šostar Turk “Hospital Textiles, Are They a Possible Vehicle for Healthcare-Associated Infections?” Int J Environ Res Public Health. 2012 Sep; 9(9): 3330–3343.

Described laundering condition	Added disinfection agent or bleach	Surviving microorganism	Reference
10 minutes at 60° C	No	<i>Enterococcus faecium</i>	Wilcox and Jones 1995
10 min at 60° C or 3 min at 71 ° C	No	Certain strains of <i>Enterococcus faecalis</i> and <i>Enterococcus faecium</i>	Orr 2002
Less than 10 min at 60° C	3 ml Peroxyacetic acid/kg textiles	<i>Enterococcus faecium</i> , <i>Staphylococcus aureus</i> , <i>Pseudomonas aeruginosa</i> and <i>Enterobacter aerogenes</i>	Fijan et al 2007
20 mint at 30° C	10 ml Sodium hypochlorate/kg textiles or 12.5 ml peroxyacetic acid/kg textiles	<i>Enterococcus faecium</i> , <i>Enterobacter aerogenes</i>	Fijan et al 2010
43 min at 30° C	10 ml Sodium hypochlorate/kg textiles	<i>Enterococcus faecium</i>	
13 min at 49° C	Added chlorine bleach (without specifications)	<i>Staphylococcus aureus</i> , <i>Klebsiella pneumoniae</i>	Walter et al 1975
66° C	Added chlorine bleach cycle (without specifications)	<i>Staphylococcus aureus</i> , Klebsiella and <i>Enterobacter</i> species	Smith et al 1987
8 min at 47.8° C	0.58 Chlorine bleach/kg	Predominantly aerobic bacteria, Staphylococci and total coliforms	Christian et al 1983
77.2° C	0.11 Chlorine bleach/kg		
22.2° C	Low temperature bleach (without specification)	Predominantly Enterobacteriaceae, Pseudomonadaceae and <i>Staphylococcus</i> sp	Blaser et al 1984
71. 1° C	High temperature bleach (without specification)		
Typical program for hospital bed linen	50 ppm Chlorine, 54 ppm peroxid, 100 ppm peroxide	<i>Clostridium difficile</i> spores	Hellickson & Owens 2007

“Reports of hospital textiles as possible source of infection in patients.” taken directly from:  
 Sabina Fijan and Sonja Šostar Turk “Hospital Textiles, Are They a Possible Vehicle for Healthcare-Associated Infections?” Int J Environ Res Public Health. 2012 Sep; 9(9): 3330–3343.

Microorganism	Hospital textile	Reference
Streptococcus pyogenes	Babies' vests contamination of dryers)	Brunton 1995
Bacillus cereus	Cleaned hospital linen Cleaned hospital linen Cleaned infants' nappies Reused towels Towels and bedsheets	Barrie et al 1994 Barrie et al 1992 Birch et al 1981 Dohmae et al 2008 Sasahara et al 2011
MRSA	Bed linen Linen	Creamer & Humphreys 2008 Shiomori et al 2002
Pseudomonas aeruginosa	Patients' clothes, bed linen	Panagea et al 2005
VRE	Drawsheet	Bonten et al 1996
Staphylococcus aureus	Mattress	Ndawula & Brown 1991
Antibiotic resistant coliform bacilli	Blankets, mattresses	Kirby et al 1956
Trichophyton interdigitale	Contaminated socks	English et al 1967



## HOW CLEAN LINEN BECOMES RE-CONTAMINATED

OUTBREAKS OF INFECTIONS ASSOCIATED WITH LINENS HAVE BEEN REPORTED TO BE ASSOCIATED WITH:

- PROCESS FAILURE DURING LAUNDERING
- CONTAMINATION DURING STORAGE (INCLUDING DUST ACCUMULATION)
- HANDLING OF LINEN WITH CONTAMINATED GLOVES/HANDS

MICROBIOLOGIC TESTING FOR CERTIFICATION OF LINEN AND TEXTILES IS NOW AVAILABLE IN THE US.<sup>8</sup>



# CONTAMINATED RE-USABLE MOP HEADS AND CLEANING CLOTHS



- SOOKLAL PUBLISHED AN ACCOUNT OF A *CLOSTRIDIUM DIFFICILE* OUTBREAK LINKED TO A LAUNDRY MACHINE MALFUNCTION IN 2014 WHICH RESULTED IN CONTAMINATED RE-USABLE MOP PADS.<sup>11</sup>
- OPEN PACKETS OF UNWOVEN RAYON CLOTHS, USED FOR ENVIRONMENTAL CLEANING, WERE FOUND TO BE CONTAMINATED WITH *B. CEPACIA*, *ALCALIGENES XYLOSOXIDANS*, *PSEUDOMONAS FLUORESCENS*, *PSEUDOMONAS AERUGINOSA* AND *B. CEPACIA*.<sup>12</sup>
- RE-USABLE CLEANING CLOTHS HAVE BEEN IMPLICATED IN AN OUTBREAK OF *BACILLUS CEREUS*.<sup>13</sup>



## CONTAMINATED RE-USABLE CLEANING CLOTHS

- A REUSABLE CLOTH IMPREGNATED WITH DISINFECTANT INITIALLY PERFORMED WELL AGAINST ALL TEST ORGANISMS, BUT WAS LESS RELIABLE AGAINST *STAPHYLOCOCCUS AUREUS* AND *STREPTOCOCCUS FAECALIS*, AFTER THE CLOTH HAD BEEN USED AND RINSED SEVERAL TIMES.<sup>14</sup>
- MICROFIBER CLOTHS SHOWED THE BEST RESULTS WHEN BEING USED IN NEW CONDITION.<sup>15</sup>
- IF RINSING IS NOT SUFFICIENT, DIRTY CLOTHS WILL RETURN TO SERVICE. RESIDUAL LINT IN THE MACHINE FROM OTHER FABRICS MAY PLUG THE MICROFIBER CHANNELS.<sup>15</sup>
- IF DISPOSABLE MICROFIBER IS USED, THERE IS NO RISK OF PATHOGEN TRANSMISSION DUE TO IMPROPER LAUNDERING METHODS OR MALFUNCTIONING LAUNDRY EQUIPMENT.<sup>15</sup>



## CONTAMINATED REUSABLE MOP HEADS

- IN ONE STUDY, LEVELS OF *C. DIFFICILE* WERE STILL DETECTED AFTER LAUNDERING MOP HEADS. EVEN AFTER BEING SOAKED FOR 8 HOURS IN A DETERGENT/DISINFECTANT, THE BACTERIAL LOAD WAS STILL RELATIVELY HIGH (APPROXIMATELY  $10^2$  CFU/50 CM<sup>2</sup>).
- DISPOSABLE MICROFIBER MOP HEADS ELIMINATES THE RISK OF PATHOGEN TRANSMISSION DUE TO IMPROPER LAUNDERING METHODS OR MALFUNCTIONING LAUNDRY EQUIPMENT. <sup>16</sup>

# CONTAMINATED PRIVACY CURTAINS

- PATIENT PRIVACY CURTAINS MAY POSE A HIGH RISK FOR PATHOGEN TRANSMISSION BECAUSE THEY ARE FREQUENTLY CONTACTED SURFACES AND ARE INFREQUENTLY CLEANED.
- PRIVACY CURTAINS ARE DIFFICULT TO PUT UP AND TAKE DOWN, AND CONSEQUENTLY ARE NOT LAUNDERED AS FREQUENTLY AS BED LINEN OR PATIENT GOWNS.
- PRIVACY CURTAINS HAVE BEEN IMPLICATED IN OUTBREAKS INCLUDING ONE IN AN INTENSIVE CARE UNIT DUE TO CONTAMINATION WITH CARBAPENEM-RESISTANT ACINETOBACTER.<sup>17</sup>

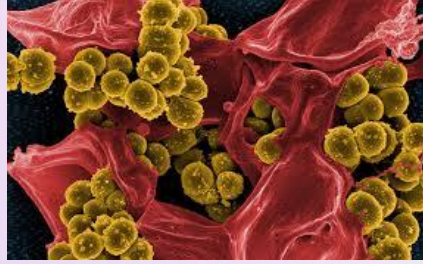


# CONTAMINATED SCRUBS AND UNIFORMS



- A GROWING BODY OF EVIDENCE SUGGESTS THAT HCWS (HEALTHCARE WORKER) APPAREL IS OFTEN CONTAMINATED WITH MICROORGANISMS THAT CAN CAUSE INFECTIONS.<sup>10</sup>
- THE REPORT BY BRADY CONCLUDES THAT THE PARAINFLUENZA VIRUS CAN SURVIVE 4 HOURS ON CLOTHING.<sup>18</sup>
- IN A STUDY BY PERRY AND CO-WORKERS, MICROBIOLOGICAL SAMPLING OF NURSES' UNIFORMS YIELDED *STAPHYLOCOCCUS AUREUS*, *CLOSTRIDIUM DIFFICILE* AND VANCOMYCIN-RESISTANT ENTEROCOCCI (VRE) BEFORE AND AFTER THE WEARING.<sup>19</sup>





## SCRUBS AND UNIFORMS CURRENT STRATEGY

- AORN (ASSOCIATION OF PERIOPERATIVE REGISTERED NURSES) AND OTHER PROFESSIONAL ORGANIZATIONS RECOMMEND THAT FACILITY VS. HOME LAUNDERED SCRUBS AND UNIFORMS ARE USED IN HIGH RISK SETTINGS SUCH AS THE OPERATING ROOM.<sup>20</sup>
- SCRUBS AND UNIFORMS LAUNDERED AT HOME ARE SUBJECT TO RECONTAMINATION BY ALL MANNER OF BACTERIA LADEN DEBRIS INCLUDING FOOD AND PET HAIR IN THE HOME AND IN THE CAR.
- IN ONE 2012 STUDY, SIGNIFICANTLY HIGHER BACTERIA COUNTS WERE ISOLATED FROM HOME-LAUNDERED SCRUBS AND UNWASHED SCRUBS THAN FROM NEW, HOSPITAL-LAUNDERED, AND DISPOSABLE SCRUBS.<sup>21</sup>



# CONTAMINATED PATIENT LINEN

- CLEAN PATIENT BED LINEN HAS BEEN IMPLICATED IN OUTBREAKS INCLUDING ONE THAT RESULTED IN RHIZOPUS INFECTION IN SIX PATIENTS AND A SECOND THAT RESULTED IN THE DEATH OF FIVE IMMUNOSUPPRESSED PATIENTS FROM ZYGOMYCOSIS INFECTION.<sup>22</sup>
- OUTBREAKS HAVE RESULTED FROM CONTAMINATED LINEN WHICH WAS NOT ADEQUATELY PROTECTED DURING HANDLING AND TRANSPORT, FROM THE TIME IT LEFT THE LAUNDRY, UNTIL THE TIME IT CAME INTO CONTACT WITH PATIENTS.<sup>23</sup>



# CONTAMINATED PATIENT LINEN



- SEVERAL PUBLISHED STUDIES REPORTED THE CULTURE RESULTS OF LAUNDERED READY TO USE HOSPITAL LINEN, USING RODAC AGAR CONTACT PLATES AND SWAB CULTURING OVER A PERIOD OF 5 YEARS BETWEEN 2004 AND 2008.
- THE MICROORGANISMS CULTURED INCLUDED: COAGULASE NEGATIVE STAPHYLOCOCCI, CORYNEBACTERIUM SPP., MICROCOCCUS SPP., BACILLUS SPP., NON-FERMENTATIVE GRAM NEGATIVE BACILLI, ENTEROCOCCUS SPP., SAPROPHYTIC GRAM NEGATIVE BACILLI, MOLDS AND ROTAVIRUS.<sup>8</sup>

# CONTAMINATED LINEN

- WILCOX AND JONES REPORT THAT MANY ISOLATES OF *ENTEROCOCCUS FAECIUM* SURVIVE EXPOSURE TO LAUNDERING TEMPERATURES SPECIFIED IN THE U.K. DEPARTMENT OF HEALTH GUIDELINES (60 °C FOR 10 MIN).<sup>24</sup>
- ANOTHER STUDY BY ORR AND CO-WORKERS CONFIRMS SURVIVAL OF CERTAIN STRAINS OF ENTEROCOCCI AT LAUNDERING TEMPERATURES AS HIGH AS 71 °C. THEY CONCLUDED THAT HOSPITAL LINEN IS A POSSIBLE SOURCE OF ENTEROCOCCAL CROSS-INFECTION.<sup>25</sup>
- IT HAS BEEN REPORTED THAT *CLOSTRIDIUM DIFFICILE* SPORES CAN SURVIVE TEMPERATURES AND CHEMICAL TREATMENT OF TYPICAL HOSPITAL LAUNDERING CYCLES AND THAT CROSS-CONTAMINATION OF *CLOSTRIDIUM DIFFICILE* SPORES CAN OCCUR ON BED LINEN DURING A WASH CYCLE.<sup>8</sup>





## CONTAMINATED FABRIC FURNITURE

- SOFT SURFACES INCLUDING FABRIC COVERED FURNITURE ARE REPORTED TO COMPRISE SOME OF THE MOST FREQUENTLY TOUCHED ITEMS IN THE PATIENT ENVIRONMENT.
- THE CDC EVS GUIDELINE RECOMMENDS AVOIDING USE OF FABRIC COVERED FURNITURE IN PATIENT CARE AREAS DUE TO THE DIFFICULTY IN COMPREHENSIVELY CLEANING.
- ONE STRATEGY TO ENSURING A SAFE PATIENT ENVIRONMENT IS TRANSITIONING FROM FABRIC TO CLEANABLE FURNITURE.<sup>26</sup>

## **4. EVIDENCE BASED SOLUTIONS – THE BASICS AND SUPPLEMENTAL MEASURES**







# CURRENT LAUNDRY GUIDELINES

- A SUCCESSFUL LAUNDERING PROCEDURE IS DEPENDENT ON SEVERAL FACTORS AND EACH MUCH BE OPTIMIZED.
- ACCORDING TO SINNER THESE FOUR INTERCONNECTED FACTORS OF THE LAUNDERING PROCEDURE ARE: DURATION, MECHANICAL ACTION, CHEMICALS AND TEMPERATURE.
- IF ONE OF THESE FACTORS IS DECREASED, FOR EXAMPLE TEMPERATURE, THEN OTHER FACTORS SUCH AS CHEMICALS, MECHANICAL ACTION OR TIME MUST BE INCREASED TO ACHIEVE THE SAME LAUNDERING AND DISINFECTING EFFECT.<sup>27</sup>





# CURRENT LAUNDRY GUIDELINES

- CURRENT INDUSTRIAL LAUNDRY PROCESSES ACHIEVE MICROBIAL REDUCTIONS VIA PHYSICAL, CHEMICAL, AND THERMAL ACTIONS, ALL OF WHICH RESULT IN PRODUCING HCT (HYGIENICALLY CLEAN TEXTILES).
- THE ACCREDITATION STANDARDS FOR PROCESSING REUSABLE TEXTILES FOR HEALTHCARE FACILITIES, COVER THE COMPLETE TEXTILE PROCESSING CYCLE, FROM HANDLING AND TRANSPORTING, TO IN-PLANT PROCESSING AND DELIVERY BACK TO THE HEALTHCARE FACILITY.
- THE STANDARDS ALSO COVER MANY BASIC CONSIDERATIONS, SUCH AS FACILITY LAYOUT, PERSONNEL TRAINING, AND CUSTOMER SERVICE.<sup>28</sup>

# THE BASICS OF MANUAL CLEANING SOLID AND SOFT SURFACES IN HEALTHCARE



- THE STANDARD FOR CLEANING SOLID SURFACES INVOLVES MANUAL WIPING AND MOPPING USING FRICTION, AND EMPLOYING EPA APPROVED HOSPITAL DISINFECTANTS CAPABLE OF KILLING THE HEARTIEST OF PATHOGENS.
- CLEANING FOCUSES ON HIGH TOUCH SURFACES AND INVOLVES BASIC PRINCIPALS INCLUDING CLEANING IN A DIRECTION OF TOP TO BOTTOM, AND CLEAN TO DIRTY.
- CLEANING SOFT SURFACES IS PERFORMED VIA WIPING, SPRAYING (NON-AEROSOL), AND LAUNDERING.<sup>29</sup>

# SOLID SURFACE CLEANING MICROFIBER



- MICROFIBER HAS BEEN PROVEN SUPERIOR TO COTTON FOR REMOVAL OF BIOBURDEN FROM ENVIRONMENTAL SURFACES.<sup>30</sup>
- MICROFIBER HAS BEEN SHOWN TO BE SUPERIOR TO COTTON CLOTHS IN REDUCING THE TRANSFER OF *CLOSTRIDIUM DIFFICILE* SPORES BETWEEN SURFACES.<sup>13</sup>
- MICROFIBER HAS DEMONSTRATED SUPERIOR MICROBIAL REMOVAL COMPARED WITH COTTON STRING MOPS WHEN USED WITH A DETERGENT CLEANER.<sup>13</sup>

# DIFFERENCE IN HARD AND SOFT SURFACES



- STUDIES SUGGEST THAT THE LEVEL OF BACTERIAL CONTAMINATION ON HARD SURFACES THAT RESULTS IN INCREASED INFECTION RISK IS 2.5 CFU/CM<sup>2</sup> AEROBIC AND 1 CFU/CM<sup>2</sup> FOR SPECIFIC ORGANISMS OF CONCERN.
- IT IS NOT KNOWN WHAT LEVEL OF CONTAMINATION ON TEXTILES/SOFT SURFACES INCREASES THE RISK OF INFECTION. THIS IS BECAUSE TEXTILES ARE ALWAYS IN CONTACT WITH PATIENTS, HAVE A LARGER CONTACTED SURFACE AREA AND CAN CONTRIBUTE TO AEROSOLIZATION (BED LINEN).
- THERE ARE MORE STUDIES AND RESOURCES GUIDING THE CLEANING AND DISINFECTION OF HARD SURFACES THAN SOFT SURFACES.
- HARD STATIC SURFACES ARE EASIER TO CLEAN AND DISINFECT THAN SOFT SURFACES.<sup>31</sup>

# HARD SURFACE DISINFECTION



- HARD SURFACES IN THE NEAR PATIENT ENVIRONMENT INCLUDE BEDSIDE RAILS, TABLE, PHONE, TV REMOTE.
- DISINFECTION INVOLVES TWO STEP PROCESS – REMOVAL OF BIOBURDEN (CLEANING), FOLLOWED BY APPLYING THE DISINFECTANT FOR THE PRESCRIBED CONTACT TIME.
- DISINFECTION IS ACCOMPLISHED WITH CHEMICALS WHICH KILL 99.999% OF GERMS ON HARD, NON-POROUS SURFACES OR OBJECTS.<sup>32</sup>



# QUALITY MONITORING SOLID AND SOFT SURFACES



- THE CDC (CENTERS FOR DISEASE CONTROL AND PREVENTION) RECOMMENDS THAT ALL HOSPITALS DEVELOP PROGRAMS TO OPTIMIZE THE THOROUGHNESS OF HIGH TOUCH SOLID SURFACE CLEANING AS PART OF TERMINAL ROOM CLEANING AT THE TIME OF DISCHARGE OR TRANSFER OF PATIENTS.<sup>33</sup>
- QUALITY MONITORING OF THE CLEANLINESS OF HARD SURFACES SHOULD ALSO BE PERFORMED. QUALITY MONITORING TOOLS INCLUDE: ATP BIOLUMINESCENCE, FLUORESCENT MARKERS, AGAR SLIDE CULTURES, SWAB CULTURES, DIRECT PRACTICE OBSERVATION.<sup>34</sup>
- THERE IS NO STANDARD QUALITY MONITORING PROCESS FOR SOFT SURFACES IN HEALTHCARE FACILITIES, ONCE LAUNDRY LEAVES THE PLANT.



## QUALITY MONITORING SOLID AND SOFT SURFACES

- MICROBIOLOGICAL TESTING OF HYGIENICALLY CLEAN (SANITIZED) HEALTHCARE TEXTILES FOR CERTIFICATION PURPOSES IS NOW AVAILABLE IN THE UNITED STATES.
- CERTIFICATION AS HYGIENICALLY CLEAN IS PROVIDED VIA LAUNDRY PLANT INSPECTION AND THIRD-PARTY, QUANTIFIED BIOLOGICAL TESTING. INSPECTION AND RE-INSPECTION VERIFY THAT ITEMS ARE WASHED, DRIED, IRONED, PACKED, TRANSPORTED AND DELIVERED USING BEST MANAGEMENT PRACTICES (BMPS) TO MEET KEY DISINFECTION CRITERIA. BETWEEN INSPECTIONS, ONGOING MICROBIAL TESTING AT THE LAUNDRY PLANT, QUANTIFIES CLEANLINESS AND ADHERENCE TO BMPS. ONCE LAUNDRY LEAVES PLANT THERE IS NO FURTHER PROCESS FOR ENSURING CLEANLINESS QUALITY.<sup>28</sup>

# SOFT SURFACE DISINFECTION AND SANITIZING



- DISINFECTION IS THE PROCESS OF CLEANING SOMETHING, ESPECIALLY WITH A CHEMICAL, IN ORDER TO DESTROY BACTERIA BUT NOT SPORES.
- SANITIZING IS THE USE OF A CHEMICAL PRODUCT OR DEVICE THAT REDUCES THE NUMBER OF GERMS ON TEXTILES TO A LEVEL CONSIDERED SAFE BY PUBLIC HEALTH STANDARDS OR REQUIREMENTS. SANITIZING KILLS MOST GERMS BUT NOT ALL OF THEM.
- LAUNDRY ADDITIVE BLEACH AND QUATS HAVE SANITIZING CLAIMS.
- BOTH DISINFECTION AND SANITIZING ARE ALWAYS A TWO STEP PROCESSES, WITH CLEANING REQUIRED FIRST.<sup>28</sup>
- DISINFECTION REFERS TO INSTRUMENTS AND SOLID SURFACES, WHILE SANITIZING REFERS TO TEXTILES.

# SOFT SURFACE DISINFECTION AND SANITIZING



- THE U.S. EPA REGULATES SANITIZERS.
- ENVIRONMENTAL FACTORS, SUCH AS TEMPERATURE AND RELATIVE HUMIDITY, CAN INFLUENCE SURVIVAL OF ENTERIC VIRUSES ON NON-LAUNDERABLE SOFT SURFACES.
- YEARGIN AND TEAM PUBLISHED A STUDY IN 2016 ON THE SURVIVAL AND INACTIVATION OF ENTERIC VIRUSES (E.G. NOROVIRUS) ON NON-LAUNDERABLE SOFT SURFACES (FURNITURE AND CARPET)
  - VIRUSES SURVIVED BETWEEN 0 HOURS AND 140 DAYS.
  - CHLORINE, GLUTARALDEHYDE, VAPOROUS OZONE, AND HYDROGEN PEROXIDE WERE THE MOST EFFICACIOUS AGAINST ENTERIC VIRUSES (> 3-LOG REDUCTION).<sup>35</sup>

# ARE ADJUNCTIVE MEASURES NEEDED IN ORDER TO MINIMIZE THE RISK OF CONTAMINATED TEXTILES?

“HEALTHCARE FACILITIES ARE OBLIGATED TO ENSURE ALL NECESSARY MEASURES TO PREVENT OR LIMIT THE SPREAD OF HEALTHCARE ASSOCIATED INFECTIONS. ONE OF THE POSSIBLE VEHICLES OF TRANSMISSION IS INANIMATE FOMITES SUCH AS TEXTILES.<sup>8</sup>”





# ADJUNCTIVE MEASURES TO SUPPORT PATHOGEN FREE TEXTILES

- SILVER ION LAUNDRY ADDITIVE
- COPPER OR OTHER IMPREGNATED FABRICS
- FLUID REPELLANT UNIFORMS
- CHLORINE FABRIC TREATMENT
- NANO TREATED TEXTILES





## ADJUNCTIVE MEASURES SILVER ION BASED SOLUTION ADDITIVE

- TREATING HOSPITAL TEXTILES WITH IONIC SILVER AFTER EACH WASHING RESULTS IN A SIGNIFICANT DECREASE IN MICROBIAL CONTAMINATION.
- IN ONE STUDY A TOTAL OF 1912 GOWNS AND 2074 SHEETS WERE TREATED WITH A SILVER ION BASED SOLUTION AFTER THE WASH CYCLE.
- THERE WAS AN 89% REDUCTION IN TOTAL AEROBIC BACTERIAL COLONIES AFTER SILVER TREATMENT ON PRE-PATIENT USE GOWNS AND 88% REDUCTION ON PRE-PATIENT USE SHEETS.
- AND THERE WAS A 89% AND 74% REDUCTION IN POST PATIENT USE GOWNS AND SHEETS. <sup>36</sup>

# SILVER – HOW IT WORKS



- SILVER KILLS BACTERIA BY INTERACTING WITH MICROBIAL PROTEINS, DESTROYING CELL WALLS, STOPPING RESPIRATION AND PROHIBITING REPLICATION
- THE ANTIMICROBIAL PROPERTIES OF SILVER HAVE BEEN KNOWN TO CULTURES ALL AROUND THE WORLD FOR MANY CENTURIES.
- THE PHONECIANS STORED WATER AND OTHER LIQUIDS IN SILVER COATED BOTTLES TO DISCOURAGE CONTAMINATION BY MICROBES.
- AT ONE TIME SILVER DOLLARS WERE PLACED IN MILK BOTTLES TO KEEP MILK FRESH.
- IN 1884 IT BECAME A COMMON PRACTICE TO ADMINISTER DROPS OF AQUEOUS SILVER NITRATE TO NEWBORN'S EYES TO PREVENT THE TRANSMISSION OF *NEISSERIA GONORRHOEAE* FROM INFECTED MOTHERS TO CHILDREN DURING CHILDBIRTH.<sup>37</sup>

# ADJUNCTIVE MEASURES

## COPPER IMPREGNATED TEXTILES



- COPPER IMPREGNATED TEXTILES FUNCTION AS AN ENGINEERING CONTROL, MINIMIZING THE ACQUISITION, RETENTION AND TRANSMISSION OF INFECTIOUS PATHOGENS BY REDUCING THE LEVELS OF BIOBURDEN AND MICROBIAL SUSTAINABILITY.<sup>10</sup>
- IN ONE STUDY OF COPPER IMPREGNATED PATIENT LINEN THERE WAS A 24% REDUCTION IN HAI PER 1000 HOSPITALIZATION-DAYS ( $P < 0.05$ ), AND A 32.8% REDUCTION IN TOTAL NUMBER OF DAYS OF ANTIBIOTIC ADMINISTRATION PER 1000 HOSPITALIZATION-DAYS ( $P < 0.0001$ ).<sup>37</sup>
- IN ADDITION THERE WAS A SAVING OF APPROXIMATELY 27% IN COSTS OF ANTIBIOTICS, HAI-RELATED TREATMENTS, X-RAYS, DISPOSABLES, LABOR, AND LAUNDRY.<sup>37</sup>



## COPPER – HOW IT WORKS

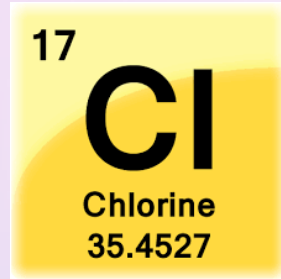
- COPPER CAUSES THE BACTERIAL OUTER MEMBRANE OF MICROORGANISMS TO RUPTURE, THROUGH WHICH THE CELL LOSES VITAL NUTRIENTS AND WATER, CAUSING A GENERAL WEAKENING OF THE CELL.
- AFTER MEMBRANE PERFORATION, COPPER CAN INHIBIT ANY GIVEN ENZYME AND STOP THE CELL FROM TRANSPORTING OR DIGESTING NUTRIENTS, FROM REPAIRING ITS DAMAGED MEMBRANE, FROM BREATHING OR MULTIPLYING.
- IT IS ALSO THOUGHT THAT THIS IS WHY SUCH A WIDE RANGE OF PATHOGENS ARE SUSCEPTIBLE TO CONTACT ACTION BY COPPER.<sup>38</sup>
- ***PROVEN IN MULTIPLE STUDIES TO REDUCE HAI***



# ADJUNCTIVE MEASURES FLUID REPELLANT UNIFORMS



- THE FLUID RESISTANT UNIFORM TECHNOLOGY REDUCES THE ACQUISITION AND RETENTION OF MICROORGANISMS ON CLOTHING.
- THESE SCRUBS AND UNIFORMS ARE DESIGNED AS A REPLACEMENT FOR TRADITIONAL, EVERY-DAY HOSPITAL ATTIRE TO HELP REPEL SPLATTER AND SPILLS OF FLUIDS AND OTHER MATERIAL ON THE FABRIC.
- THE FABRIC ALSO CONTAINS AN ANTIMICROBIAL SUBSTANCE SHOWN IN LABORATORY AND HOSPITAL SETTINGS TO INHIBIT CERTAIN TESTED BACTERIA FROM GROWING ON THE FABRIC UNDER THE CONDITIONS OF THE TESTS.<sup>39</sup>
- ***THE ABILITY OF THE FABRIC TO REDUCE INFECTIONS HAS NOT BEEN STUDIED.***



## ADJUNCTIVE MEASURES CHLORINE FABRIC TREATMENT

- THIS LINE OF HEALTH CARE APPAREL CONTINUOUSLY KILLS 99.9 PERCENT OF STAPH, SALMONELLA, E. COLI, HEPATITIS A, PNEUMONIA AND OTHER HARMFUL MICROORGANISMS
- THE PATENTED FABRIC USED TO MAKE SCRUBS, LAB COATS AND PRIVACY CURTAINS WORKS BY BINDING CHLORINE MOLECULES TO ITS SURFACE AND IS PROVEN TO KILL GERMS ON CONTACT FOR UP TO 120 DAYS BETWEEN WASH CYCLES.
- THE CHLORINE IS COMPLETELY REACTIVATED WITH EVERY WASH, SAF-T MAINTAINS BACTERICIDAL EFFECTIVENESS AT A 3-LOG RATE THROUGH 75 INDUSTRIAL WASHES WHEN LAUNDERED AS DIRECTED USING EPA-REGISTERED BLEACH.<sup>40</sup>
- ***NO PUBLISHED EVIDENCE OF EFFICACY TO DATE.***

# ADJUNCTIVE MEASURES NANOTECHNOLOGY



- FE (IRON) AND N (NITROGEN) CO-DOPED  $\text{TiO}_2$  (TITANIUM OXIDE) NANOPARTICLES HAVE BEEN USED TO IMPREGNATE POLYESTER (PES) MATERIALS.
- ALL TREATED PES MATERIALS SPECIFICALLY INHIBITED THE GROWTH OF GRAM-NEGATIVE BACILLI STRAINS AFTER 15 MIN OF CONTACT, BEING PARTICULARLY ACTIVE AGAINST *PSEUDOMONAS AERUGINOSA*.
- THIS TECHNOLOGY COULD PROVIDE FABRICS WITH SHORT TERM PROTECTION AGAINST MICROBIAL COLONIZATION, THAT COULD BE USED FOR PREVENTING PATIENTS' ACCIDENTAL CONTAMINATION WITH MICROORGANISMS FROM THE HOSPITAL ENVIRONMENT.<sup>41</sup>
- **PRODUCT STILL IN DEVELOPMENT**

TECHNOLOGY ATTRIBUTES	Silver Ion Based Solution Additive	Copper Impregnated Textiles	Fluid Repellant uniforms	Chlorine Fabric Treatment	Nanotechnology
Sustained Antimicrobial Effect	✓	Degrades over time	Lasts 50 uses	Requires Moisture	Degrades over time
Repells Bacteria/Mositure	X	X	✓	X	X
Clinical Supporting Data	✓	✓	✓	X	X
Relative Cost	\$\$	\$\$\$\$	\$\$\$\$	\$	\$\$\$\$
Safe For Neonatal	✓	✓	X	✓	?
Utilizes Existing Processes and Textile Inventory	✓	X	X	X	X
Maintains Look and Feel	✓	X	✓	X	?
QA to Ensure Efficacy	✓	X	X	X	X
Low Environmental Impact	✓	Metals degrade from fabric and release into environment	X	X	?
Designed for All Fabric Types	✓	X	X	✓	X

## COMPARATIVE ANALYSIS

## **5. THE FUTURE OF HOSPITAL CLEANING?**





# BUNDLE APPROACH TO ROOM CLEANING



“SIMILAR TO THE IHI (INSTITUTES FOR HEALTHCARE IMPROVEMENT) BUNDLE MODELS FOR CENTRAL LINES AND VENTILATORS TO PREVENT HAI, AN EVIDENCE-BASED CARE BUNDLE IS ALSO NEEDED FOR A SUCCESSFUL ENVIRONMENTAL CLEANING AND DISINFECTION PROGRAM.”<sup>42</sup>

# A FUTURE HOSPITAL CLEANING BUNDLE ELEMENTS MIGHT INCLUDE THE FOLLOWING:

1. HARD SURFACE CLEANING
2. SOFT SURFACE CLEANING
3. ADJUNCTS (UV, HP VAPOR, COPPER, SILVER ION, FLUID REPELLANT, ETC.)
4. QUALITY MONITORING
5. TOOLS:
  - BUSINESS CASE TEMPLATE FOR ADEQUATE EVS RESOURCES
  - PRODUCT UTILIZATION GUIDELINES TEMPLATE
  - POSTER TEMPLATE
  - VIDEOS
  - RESOURCES AND REFERENCES



## 6. REFERENCES



1. HOOKER EA, BOCHAN M, REIFF TT, BLACKWELL C, WEBB KW, HART KW. DECREASING CLOSTRIDIUM DIFFICILE HEALTH CARE-ASSOCIATED INFECTIONS THROUGH USE OF A LAUNDERABLE MATTRESS COVER. AM J INFECT CONTROL 2015 DEC 1;43(12):1326-30. DOI: 10.1016/J.AJIC.2015.07.002. EPUB 2015 OCT 21.
2. CDC WEBSITE ARTICLE: [HTTPS://WWWNC.CDC.GOV/EID/ARTICLE/18/2/10-1611\\_ARTICLE](https://wwwnc.cdc.gov/eid/article/18/2/10-1611_article)
3. CDC WEBSITE ARTICLE: [HTTPS://WWWNC.CDC.GOV/EID/ARTICLE/11/10/05-0508\\_ARTICLE](https://wwwnc.cdc.gov/eid/article/11/10/05-0508_article)
4. NOVOSAD S ET AL. "NOTES FROM THE FIELD: PROBABLE MUCORMYCOSIS AMONG ADULT SOLID ORGAN TRANSPLANT RECIPIENTS AT AN ACUTE CARE HOSPITAL — PENNSYLVANIA, 2014–2015". MMWR WEEKLY / MAY 13, 2016 / 65(18);481–482.
5. WHO NEWS RELEASE: [WWW.WHO.INT/MEDIACENTER/NEWS/RELEASES/2017/BACTERIA-ANTIBIOTICS-NEEDED/EN/](http://www.who.int/mediacentre/news/releases/2017/bacteria-antibiotics-needed/en/)
6. ANDERSON DJ, ET AL. "ENHANCED TERMINAL ROOM DISINFECTION AND ACQUISITION AND INFECTION CAUSED BY MULTIDRUG-RESISTANT ORGANISMS AND CLOSTRIDIUM DIFFICILE (THE BENEFITS OF ENHANCED TERMINAL ROOM DISINFECTION STUDY): A CLUSTER-RANDOMISED, MULTICENTRE, CROSSOVER STUDY." LANCET. 2017 FEB 25;389(10071):805-814.
7. WEBER DJ, ANDERSON D, RUTALA WA. THE ROLE OF THE SURFACE ENVIRONMENT IN HEALTHCARE-ASSOCIATED INFECTIONS. CURR OPIN INFECT DIS. 2013 AUG;26(4):338-44.
8. FIJAN S, TURK SŠ. HOSPITAL TEXTILES, ARE THEY A POSSIBLE VEHICLE FOR HEALTHCARE ASSOCIATED INFECTIONS? INT J ENVIRON RES PUBLIC HEALTH 2012;9:3330-43.
9. PINON A, GACHET J, ALEXANDRE V, DECHERF S, VIALETTE M. MICROBIOLOGICAL CONTAMINATION OF BED LINEN AND STAFF UNIFORMS IN A HOSPITAL. ADV MICROBIOL 2013;3:515-9.



10. MITCHELL A, SPENCER M, EDMISTON C JR. ROLE OF HEALTHCARE APPAREL AND OTHER HEALTHCARE TEXTILES IN THE TRANSMISSION OF PATHOGENS: A REVIEW OF THE LITERATURE. J HOSP INFECT. 2015 AUG;90(4):285-92.
11. SOOKLAL S, KHAN A, KANNANGARA S. HOSPITAL CLOSTRIDIUM DIFFICILE OUTBREAK LINKED TO LAUNDRY MACHINE MALFUNCTION. AM J INFECT CONTROL. 2014 JUN;42(6):674-5.
11. OIE S, ARAKAWA , FURUKAWA H, MATSUMOTO S, MATSUDA N, WAKAMATSU H. MICROBIAL CONTAMINATION OF A DISINFECTANT-SOAKED UNWOVEN CLEANING CLOTH. J HOSP INFECT. 2012 SEP;82(1):61-3.
12. SIFUENTES LY, GERBA CP, WEART I, ENGELBRECHT K, KOENIG DW. MICROBIAL CONTAMINATION OF HOSPITAL REUSABLE CLEANING TOWELS. AM J INFECT CONTROL. 2013 OCT;41(10):912-5.
13. TEBBUTT GM. LABORATORY EVALUATION OF DISPOSABLE AND REUSABLE DISINFECTANT CLOTHS FOR CLEANING FOOD CONTACT SURFACES. EPIDEMIOL INFECT. 1988 OCT;101(2):367-75.
14. DIAB-ELSCHAHAWI M, ET AL. EVALUATION OF THE DECONTAMINATION EFFICACY OF NEW AND REPROCESSED MICROFIBER CLEANING CLOTH COMPARED WITH OTHER COMMONLY USED CLEANING CLOTHS IN THE HOSPITAL. AM J INFECT CONTROL. 2010 MAY;38(4):289-92.
15. LORENZI SD, ROMANINI L, FINZI G, SALVATORELLI G. BIOCIDES ACTIVITY OF MICROFIBER MOPS WITH AND WITHOUT SILVER AFTER CONTAMINATION. BRAZ J INFECT DIS. 2011 MAY-JUN;15(3):200-3.
16. DAS I, LAMBERT P, HILL D, NOY M, BION J, ELLIOTT T. CARBAPENEM-RESISTANT ACINETOBACTER AND ROLE OF CURTAINS IN AN OUTBREAK IN INTENSIVE CARE UNITS. J HOSP INFECT. 2002 FEB;50(2):110-4.
17. BRADY M.T., EVANS J., CUARTAS J. SURVIVAL AND DISINFECTION OF PARAINFLUENZA VIRUSES ON ENVIRONMENTAL SURFACES. AMER. J. INFECT. CONTROL. 1990;18:18–23. DOI: 10.1016/0196-6553(90)90206-8.

18. PERRY C., MARSHALL R., JONES E. BACTERIAL CONTAMINATION OF UNIFORMS. J. HOSP. INFECT. 2001;48:238–241. DOI: 10.1053/JHIN.2001.0962.
19. GUIDELINE FOR SURGICAL ATTIRE. IN: *GUIDELINES FOR PERIOPERATIVE PRACTICE*. DENVER, CO: AORN, INC; 2015:97-120.
20. NORDSTROM JM, REYNOLDS KA, GERBA CP. COMPARISON OF BACTERIA ON NEW, DISPOSABLE, LAUNDERED, AND UNLAUNDERED HOSPITAL SCRUBS. AM J INFECT CONTROL. 2012 AUG;40(6):539-43.
21. CHENG VCC, CHEN JHK, WONG SCY, LEUNG SSM, SO SYC, LUNG DC, ET AL. HOSPITAL OUTBREAK OF PULMONARY AND CUTANEOUS ZYGOMYCOSIS DUE TO CONTAMINATED LINEN ITEMS FROM SUBSTANDARD LAUNDRY. CLIN INFECT DIS 2015.
22. DUFFY J, HARRIS J, GADE L, SEHULSTER L, NEWHOUSE E, O'CONNELL H, ET AL. MUCORMYCOSIS OUTBREAK ASSOCIATED WITH HOSPITAL LINENS. PEDIATR INFECT DIS J 2014;33:472-6.
23. WILCOX M.H., JONES B.L. ENTEROCOCCI AND HOSPITAL LAUNDRY. LANCET. 1995;345:594.
24. ORR K.E., HOLLIDAY M.G., JONES A.L., ROBSON I., PERRY J.D. SURVIVAL OF ENTEROCOCCI DURING HOSPITAL LAUNDRY PROCESSING. J. HOSP. INFECT. 2002;50:133–139. DOI: 10.1053/JHIN.2001.1137.
25. CHENG VC, ET AL. “HAND-TOUCH CONTACT ASSESSMENT OF HIGH-TOUCH AND MUTUAL-TOUCH SURFACES AMONG HEALTHCARE WORKERS, PATIENTS, AND VISITORS”. J HOSP INFECT. 2015 JUL;90(3):220-5.
26. TURK S.S., PETRINIC I., SIMONIC M. LAUNDRY WASTEWATER TREATMENT USING COAGULATION AND MEMBRANE FILTRATION. RESOUR. CONSERV. RECYC. 2005;44:185–196.

27. SEHULSTER LM. HEALTHCARE LAUNDRY AND TEXTILES IN THE UNITED STATES: REVIEW AND COMMENTARY ON CONTEMPORARY INFECTION PREVENTION ISSUES. INFECTION CONTROL HOSP EPIDEMIOL. 2015 SEP; 36(9) 1073-88.
28. HAN JH, SULLIVAN N, LEAS BF, PEGUES DA, KACZMAREK JL, UMSCHIED CA. "CLEANING HOSPITAL ROOM SURFACES TO PREVENT HEALTH CARE-ASSOCIATED INFECTIONS: A TECHNICAL BRIEF". ANN INTERN MED. 2015 OCT 20;163(8):598-607.
29. RUTALA WA, GERGEN MF, WEBER DJ MICROBIOLOGIC EVALUATION OF MICROFIBER MOPS FOR SURFACE DISINFECTION. AM J INFECTION CONTROL. 2007 NOV;35(9):569-73.
30. SHIOMORI T ET AL. EVALUATION OF BEDMAKING-RELATED AIRBORNE AND SURFACE METHICILLIN-RESISTANT STAPHYLOCOCCUS AUREUS CONTAMINATION. J HOSP INFECTION. 2002 JAN;50(1):30-5.
31. CLARO T, O'REILLY M, DANIELS S, HUMPHREYS H. SURFACE MICROBIAL CONTAMINATION IN HOSPITALS: A PILOT STUDY ON METHODS OF SAMPLING AND THE USE OF PROPOSED MICROBIOLOGIC STANDARDS. AM J INFECTION CONTROL 2015;43:1000-2.
32. CDC WEBPAGE EVS: [HTTPS://WWW.CDC.GOV/HAI/TOOLKITS/APPENDICES-EVALUATING-ENVIRONMENTAL-CLEANING.HTML#B](https://www.cdc.gov/hai/toolkits/appendices-evaluating-environmental-cleaning.html#B)
33. DANCER SJ. HOW DO WE ASSESS HOSPITAL CLEANING? A PROPOSAL FOR MICROBIOLOGICAL STANDARDS FOR SURFACE HYGIENE IN HOSPITALS. J HOSP INFECTION 2004;56:10-5.
34. YEARGIN T, BUCKLEY D, FRASER A, JIANG X. THE SURVIVAL AND INACTIVATION OF ENTERIC VIRUSES ON SOFT SURFACES: A SYSTEMATIC REVIEW OF THE LITERATURE. AM J INFECTION CONTROL. 2016 NOV 1;44(11):1365-1373.

35. OPENSHAW ET AL. REDUCTION IN BACTERIAL CONTAMINATION OF HOSPITAL TEXTILES BY A NOVEL SILVER-BASED LAUNDRY TREATMENT. AMERICAN JOURNAL OF INFECTION CONTROL 44 (2016) 1705-8 1707 5.
36. MAILLARD J-Y, HARTEMANN P. SILVER AS AN ANTIMICROBIAL: FACTS AND GAPS IN KNOWLEDGE. CRIT REV MICROBIOL 2013;39:373-83.
36. LAZARY A ET AL. REDUCTION OF HEALTHCARE-ASSOCIATED INFECTIONS IN A LONG-TERM CARE BRAIN INJURY WARD BY REPLACING REGULAR LINENS WITH BIOCIDAL COPPER OXIDE IMPREGNATED LINENS. INT J INFECT DIS. 2014 JUL;24:23-9.
37. SALGADO CD, SEPKOWITZ KA, JOHN JF, CANTEY JR, ATTAWAY HH, FREEMAN KD, ET AL. COPPER SURFACES REDUCE THE RATE OF HEALTHCARE-ACQUIRED INFECTIONS IN THE INTENSIVE CARE UNIT. INFECT CONTROL HOSP EPIDEMIOL 2013;34:479-86.
38. VESTAGEN WEBSITE: [HTTP://VESTAGEN.COM/](http://vestagen.com/)
39. PRIME MEDICAL WEBSITE: WWW.PRIMEMEDICAL.COM OR WWW.SAF-T-SCRUBS.COM
40. NICA IC ET AL. , INNOVATIVE SELF-CLEANING AND BIOCOMPATIBLE POLYESTER TEXTILES NANO-DECORATED WITH FE-N-DOPED TITANIUM DIOXIDE. NANOMATERIALS (BASEL). 2016 NOV 15;6(11). PII: E214.
41. HAVILL NL. BEST PRACTICES IN DISINFECTION OF NONCRITICAL SURFACES IN THE HEALTH CARE SETTING: CREATING A BUNDLE FOR SUCCESS. AM J INFECT CONTROL. 2013 MAY;41(5 SUPPL):S26-30.



# THANK YOU

TO APPLIED SILVER FOR THEIR UNRESTRICTED EDUCATIONAL GRANT FOR THIS ACTIVITY

## INSTRUCTIONS FOR OBTAINING 1.5 CH CERTIFICATE

1. COMPLETE THE ONLINE POST-TEST (MINIMUM SCORE OF 75) AND EVALUATION

2. COMPLETE ALL ITEMS IN RED

If you click "SUBMIT" and nothing happens, scroll through your screen to find items still in RED.  
Complete these items and SUBMIT

3. CLICK "GENERATE CERTIFICATE" to download or print your certificate

4. [CLICK HERE TO ACCESS POST-TEST/EVALUATION](#)