Reducing Spread of Pathogens by Environmental Surfaces in Healthcare
Prof. Syed A. Sattar, Centre for Research on Environmental Microbiology, University of Ottawa
Sponsored by Virox Technologies (www.virox.com) and Diversey Inc (www.diversey.com)

A Webber Training Teleclass
Hosted by Paul Webber  paul@webbertraining.com
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INTRODUCTION
• PAST DECADE SEEN A GREATER RECOGNITION OF HIGH-TOUCH, NON-POROUS ENVIRONMENTAL SURFACES AS VEHICLES FOR HEALTHCARE-ASSOCIATED INFECTIONS (HAI)
• UPSURGE IN DEVELOPMENT & MARKETING OF PRODUCTS & TECHNOLOGIES TO COMBAT SUCH SPREAD
• CORRESPONDING INCREASE IN CONCERNS ON CLAIMS OF ACTIVITY & SAFETY OF WHAT IS BEING USED
• A CRITICAL REVIEW OF PROGRESS & A LOOK AT THE FUTURE

PROGRESS
• UNDENIABLE INCREASE IN AWARENESS ON NEGATIVE HEALTH & ECONOMIC IMPACTS OF HAI
• CLEAR RECOGNITION THAT MANY HAI ARE PREVENTABLE
• GOVERNMENTS AT ALL LEVELS SHOWING POLITICAL WILL
• PROFESSIONAL ASSOCIATIONS, VOLUNTARY ORGANIZATIONS & INDUSTRY COALITIONS ALSO PURSUING HAI WITH RENEWED VIGOR
• REDUCTIONS IN CERTAIN TYPES OF HAI ALREADY BEING REALIZED!

PROBLEMS REMAIN!
• MANY SLOW-ACTING, INEFFECTIVE & POTENTIALLY HARMFUL CHEMICALS STILL IN USE (FIGURE)
• TRAINING, MONITORING & RECOGNITION OF HOUSE-KEEPERS REMAIN POOR
• UPDATING OF PRODUCT REGISTRATION PROCESS SLOW
• LABELS NEED TO BE MORE USER-FRIENDLY & ACCURATE
• WIPING IS COMMON, BUT ITS CONTRIBUTION RARELY ASSESSED
• MARKETING OF ‘GREEN’ PRODUCTS & TECHNOLOGIES TO BE BETTER CONTROLLED

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• PAUL WEBBER
• JASON TETRO & OTHER CREM
STAFF & STUDENTS
A READING LIST WILL BE AVAILABLE AT WWW.WEBBERTRAINING.COM

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• CREM RECEIVES RESEARCH FUNDING FROM COMPANIES, GOVERNMENTS & INTERNATIONAL AGENCIES
• I ALSO WORK AS AN ADVISOR/CONSULTANT TO NUMEROUS COMPANIES, GOVERNMENTS & INTERNATIONAL AGENCIES
• I AM A MEMBER OF THE BOARD OF DIRECTORS FOR VIROX

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DISINFECTANT USE
- >5,000 REGISTERED DISINFECTANTS IN THE U.S.
- >60% USED AGAINST HUMAN PATHOGENS
- ABOUT 275 DIFFERENT TYPES OF ACTIVES
- ANNUAL SALES OF >BILLION DOLLARS & INCREASING

HOUSE-KEEPING STAFF STILL A WEAK LINK!
- TRAINING & MONITORING OFTEN INSUFFICIENT
- PRODUCT & PROCESS OFTEN UNSUITABLE

A RECENT STUDY (BOYCE ET AL., 2011) AT A U.S. HOSPITAL FOUND:
- INCREASED NUMBERS OF BACTERIA ON DISINFECTED SURFACES
- CONTAMINATION CAME FROM A DILUTED QUAT-BASED PRODUCT STORED UNUSED FOR WEEKS IN A BUCKET FOR MOPPING
- CONTAINED ~100,000/mL OF THREE POTENTIALLY HARMFUL SPECIES
- SHOWED >100-FOLD RESISTANCE TO THE QUAT & SIX ANTIBIOTICS

% OF VRE-POSITIVE CULTURES FROM 17 ROOMS TESTED
(Eckstein et al., BMC Infect. Dis. 2007;7:61)

FLUORESCENT MARKING TOOL
- FLUORESCENT GEL INVISIBLE TO NAKED EYE
- A DAB IS PLACED ON TEST SURFACE & DRIED
- PEN-LIGHT WILL SHOW FLUORESCENCE ONLY IF SURFACE NOT PROPERLY CLEANED

WHAT ABOUT GOVERNMENT REGISTRATION?
- A REGISTRATION NUMBER HAS LIMITED VALUE!
- ANOTHER WEAK LINK
- OUTDATED REQUIREMENTS & FLAWED TESTING
- MATERIALS MANAGERS & ICPs NOT TRAINED ENOUGH TO EXERCISE JUDGMENT HERE
- A REVIEW OF THIS ISSUE IS URGENTLY NEEDED!

CURRENT ISSUES WITH LABEL CLAIMS
- OFTEN, CONTACT TIME ON LABEL FOR DISINFECTION OF ENVIRONMENTAL SURFACES TOO LONG FOR FIELD USE
- NO DIRECTION ON VOLUME:SURFACE AREA
- LACK OF CLEAR DIRECTIONS FOR PRE-CLEANING & WIPING OF CLEANED SURFACES
- LONG LISTS OF IRRELEVANT MICROBES (TABLE)
- ‘BROAD-SPECTRUM’ SHOULD MEAN MORE THAN JUST ACTIVITY AGAINST GRAM+ & GRAM- BACTERIA

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LISTS OF EPA REGISTERED PRODUCTS WITH LABEL CLAIMS AGAINST SPECIFIC TYPES OF HUMAN PATHOGENS (AS OF JANUARY 9, 2009)

<table>
<thead>
<tr>
<th>LIST #</th>
<th>TYPE OF PATHOGEN(S)</th>
<th>NO. OF PRODUCTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>MYCOBACTERIUM TUBERCULOSIS</td>
<td>164</td>
</tr>
<tr>
<td>C</td>
<td>HUMAN IMMUNODEFICIENCY VIRUS TYPE 1 (HIV-1)</td>
<td>486</td>
</tr>
<tr>
<td>D</td>
<td>HIV-1 &amp; HEPATITIS B VIRUS</td>
<td>176</td>
</tr>
<tr>
<td>E</td>
<td>HEPATITIS C VIRUS</td>
<td>127</td>
</tr>
<tr>
<td>F</td>
<td>NOROVIRUS (NORMAL-LIKE VIRUS)</td>
<td>50</td>
</tr>
<tr>
<td>H</td>
<td>METHICILLIN RESISTANT STAPHYLOCOCCUS AUREUS (MRSA) ONLY</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>VANCOMYCIN RESISTANT ENTEROCOCCUS FAECALIS OR FAECIUM (VRE) ONLY</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>MRSA &amp; VRE</td>
<td>202</td>
</tr>
</tbody>
</table>

THE FUTURE

MOMENTUM TO CONTINUE ONLY IF:

- LABEL CLAIMS AGAINST ‘BUG-OF-THE-MONTH’ DISCOURAGED
- INCORPORATE SUITABLE SURROGATES IN REALISTIC TESTS
- TESTING OF MICROBICIDES WITH WIPING ACTION IS PROMOTED
- USE OF SAFER & BETTER MICROBICIDES IS ENCOURAGED
- TESTING REQUIREMENTS ARE HARMONIZED GLOBALLY
- HOUSEKEEPING STAFF IS BETTER TRAINED & RECOGNIZED

PROBLEMS WITH WIPING

- INSUFFICIENT TRAINING & MONITORING OF STAFF
- WIPING OFTEN CURSORY & MAY ACTUALLY SPREAD CONTAMINATION
- APPLICATOR HAS ITS OWN DISINFECTANT DEMAND
- CONTACT TIME ONLY SECONDS; DISINFECTANT VOLUME <ONE MICROLITRE/CM²
- NO SUITABLE METHOD TO TEST ROLE OF WIPING

NEWER WAYS TO DECONTAMINATE HARD, NON-POROUS ENVIRONMENTAL SURFACES

- MICROBICIDE-IMPREGNATED
- GAS, MIST OR FOAM
- PHOTOSENSITIZED
- SELF-SANITIZING
- PORTABLE STEAM
- MICROBICIDE-COATED
- UV LIGHT
- REACTIVE
- HIGH-INTENSITY LIGHT

NEWER TECHNOLOGIES FOR DECONAMINATION OF ENVIRONMENTAL SURFACES

- SOME HAVE BEEN ADAPTED FROM WORK WITH INFECTIOUS BIOTHREAT AGENTS
- SEVERAL OTHERS ARE IN EARLY DEVELOPMENTAL STAGES
- SOME ARE CHEMICAL-FREE

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**GASES, MISTS & FOAMS**
- MANY ESTABLISHED & NEWER TECHNOLOGIES
  - $\text{H}_2\text{O}_2$ & CHLORINE DIOXIDE
  - CANADIAN AQUEOUS SYSTEM FOR CHEMICAL/BIOLOGICAL AGENT DECONTAMINATION (CASCADE) FOAM
  - FORMALDEHYDE, PERACETIC ACID, ETHANOL
- OFTEN REQUIRE EXPENSIVE EQUIPMENT & TRAINING
- TWO TO 24 HOURS FOR APPLICATION
- ROOM MUST BE UNOCCUPIED & SEALED
- POTENTIAL FOR CORROSION & DAMAGE

**OZONE**
- PURE OZONE ($\leq$ 25 PPM) & A QUenching GAS (TRANS-2-BUTENE) FOR DISINFECTING ROOMS (MOAT ET AL. 2009)
- $>3 \log_{10}$ DROP IN VEGETATIVE BACTERIA & C. DIFFICILE SPORES ON AGAR PLATES & HARD SURFACES IN <60 MINUTES
- OZONE (80 PPM) WITH $\text{H}_2\text{O}_2$ VAPOR (0.2-1.0%) FOR ROOM DISINFECTION (ZOUTMAN ET AL. 2011)
- $>6 \log_{10}$ REDUCTIONS IN VEGETATIVE BACTERIA & SPORES ON METAL DISKS IN 30- TO 90-MINUTES

**MICROBICIDE-IMPREGNATED SURFACES**
- TRICLOSAN IS IMPREGNATED IN PLASTICS FOR MAKING ITEMS SUCH AS COUNTER-TOPS
- MICROBICIDAL ACTIVITY MAY BE SLOW & LIMITED
- INCREASING SAFETY CONCERNS
- POTENTIAL FOR CROSS-RESISTANCE TO ANTIBIOTICS
- INACTIVE IN THE PRESENCE OF BODY FLUIDS
- TRICLOSAN USE NOW RESTRICTED IN EUROPE

**MICROBICIDE-COATED SURFACES**
- QUAT- OR SILVER-BASED POLYMERS
- CLAIM SUSTAINED OR RESIDUAL ACTIVITY
- CLAIM REDUCTION IN FREQUENCY OF DISINFECTION
- NO STANDARD METHODS TO VERIFY CLAIMS
- RISK OF GENERATION OF MICROBICIDE RESISTANCE
- HOW BROAD IS THE SPECTRUM OF ACTIVITY?

**COPPER AS A SELF-SANITIZING SURFACE** (GRASS ET AL. 2011)
- SOME 300 COPPER ALLOYS NOW REGISTERED WITH U.S. EPA AS THE ONLY ‘SELF-SANITIZING’ SURFACES
- CLAIM MICROBICIDAL ACTION BY ‘CONTACT KILLING’
  - $>60\%$ REDUCTION IN BACTERIAL LOAD COMPARED TO OTHER SURFACES SUCH AS STAINLESS STEEL
  - ACTIVITY AGAINST ALL MAJOR CLASSES OF PATHOGENS
  - LOWER RISK OF GENERATION OF COPPER RESISTANCE?
- FIELD TRIALS IN HOSPITALS NOW UNDERWAY

**REACTION-SURFACES**
- MICROBICIDAL ACTION ‘ON-COMMAND’
  - ACTIVATED ON ELECTRICAL, MAGNETIC OR ULTRASOUND STIMULATION
  - E.G., OPENING/CLOSING OF PORES ON MAGNETIZED FERROGELS BY MAGNETIC FORCE (LIU ET AL. 2008)
  - ‘ON-DEMAND’ ACTIVITY WHEN EXPOSED TO CONTAMINATION
  - MICROBIAL GROWTH AS TRIGGER; UNSAFE IN MOST SETTINGS
- PHOTOSENSITIZED SURFACES (BROVOK 2010)
  - TREATMENT OF FOOD-CONTACT SURFACES WITH NON-TOXIC DYES FOLLOWED BY EXPOSURE TO LIGHT
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UPCONVERTING VISIBLE LIGHT INTO UVC (220-280 NM) (GATES ET AL. 2013)
• GLASS COUPONS WITH BAKED-ON LUMINESCENT ACTIVATORS (PHOSPHORS)
  – CONTAMINATED WITH B. SUBTILIS SPORES
  – ~90% REDUCTION IN SPORE VIABILITY OVER 10 DAYS
• FURTHER IMPROVEMENTS IN TECHNIQUE UNDERWAY

UV IRRADIATION (REXANDROV ET AL., 2010)
PROS
  • DECONTAMINATION OF EXPOSED & SHADOWED AREAS
  • REMOTE OPERATION & DOSAGE SELECTION
  • CHEMICAL-FREE; BROAD-SPECTRUM
  • NO SEALING OF ROOM & NO SPECIAL TRAINING OF STAFF
  • FASTER (15-45 MINUTES) & LESS EXPENSIVE THAN GAS/MIST
CONS
  • POTENTIAL FOR MUTATIONS
  • ROOM MUST BE EVACUATED
  • POOR PENETRATION OF POROUS MATERIALS
  • DAMAGE OF ARTICLES ON REPEATED UV EXPOSURE

HIGH-INTENSITY LIGHT (MACLEAN ET AL., 2010)
ﬁ • BLUE LIGHT (405 nm) FROM DIODES
  • BACTERICIDAL BUT SAFE FOR HUMANS
  • SUITABLE FOR CONTINUOUS OPERATION
  • 60-90% REDUCTIONS OF MRSA IN BURN UNITS
  • NO PHOTO-SENSITIZERS NEEDED
  • DOES IT CAUSE MUTATIONS IN BACTERIA?
  • DOES IT WORK AGAINST OTHER TYPES OF NOSOCOMIAL PATHOGENS?
  • DOES IT WORK ON SHADED AREAS?
  • DOES IT WORK ON POROUS MATERIALS, E.G., LINEN?

PORTABLE STEAM GENERATORS (UY & ZOUTMAN 2010)
• CHEMICAL-FREE DEGREASING & DECONTAMINATION OF HORIZONTAL & VERTICAL SURFACES
• DISKS OF PLASTICS & METAL WITH DRIED INOCULA OF MRSA & VRE EXPOSED FOR 5 SECONDS TO STEAM
• A >MILLION-FOLD REDUCTION IN BOTH ORGANISMS
• BROAD-SPECTRUM EXCEPT FOR BACTERIAL SPORES
• ELECTRICAL SUPPLY ESSENTIAL
• MATERIALS COMPATIBILITY?
• FEASIBILITY OF USE ON LARGE SURFACE AREAS?

PRINCIPLES OF “GREEN CHEMISTRY” (ANASTAS & WARNER 1998)
1. DESIGN SAFER CHEMICALS & PRODUCTS THAT ARE FULLY EFFECTIVE WITH LITTLE OR NO TOXICITY
2. USE SAFER SOLVENTS AND REACTION CONDITIONS
3. DESIGN CHEMICALS & PRODUCTS TO DEGRADE AFTER USE SO THAT THEY DO NOT ACCUMULATE
4. MINIMIZE POTENTIAL FOR ACCIDENTS SUCH AS EXPLOSIONS, FIRES, & RELEASES TO THE ENVIRONMENT

NEW STANDARD TESTS AND GUIDELINES
• NEWER & BETTER ONES NOW AVAILABLE OR ON THE WAY
• ASTM INTERNATIONAL HAS INTRODUCED REFINED METHODS
• AOAC INTERNATIONAL IS DOING THE SAME
• ORGANIZATION FOR ECONOMIC COOPERATION & DEVELOPMENT (OECD) IS IN FINAL STAGES OF APPROVING FOUR HARMONIZED QUANTITATIVE CARRIER TESTS FOR HARD SURFACE DISINFECTANTS
• HEALTH CANADA ISSUED A NEW GUIDANCE DOCUMENT IN 2007
• EPA IS CONTINUALLY UPDATING ITS REGULATIONS
  • ‘DESIGN FOR THE ENVIRONMENT’
CONCLUDING REMARKS

- SOME PROGRESS, BUT MANY ISSUES REMAIN
- GREATER APPRECIATION OF ENVIRONMENTAL SPREAD OF HAI
- BETTER, FASTER-ACTING & SAFER MICROBICIDES NEEDED
- BETTER WAYS TO TEST NEW TECHNOLOGIES BEFORE ADOPTION
- LABEL CLAIMS TO BE BASED ON PROPER WIPE TESTING
- BETTER TRAIN, MONITOR & RECOGNIZE HOUSE-KEEPERS

COMING SOON ... 

15 June 11 (South Pacific Teleclass) Pandemic, Public Health and Emergency Care: Contemporary Trends and New Challenges for Infection Control and Infectious Diseases
Speaker: Prof. Ramon Shabam, Griffith University, Australia

21 June 11 (Free WHO Teleclass – South Pacific) Establishing an Infection Control Program for Acute Respiratory Infections and Ensuring Pandemic Preparedness
Speaker: Prof. Wing Hong Seto, Queen Mary Hospital, Hong Kong
Sponsor: World Health Organization First Global Patient Safety Challenge: Clean Care is Safer Care (www.who.int/gpsc/en)

23 June 11 Ventilator-Associated Pneumonia: Epidemiology, Diagnosis, and Prevention
Speaker: Dr. Lennox Archibald, University of Florida

29 June 11 (Free Teleclass – Broadcast live from the International Conference on Prevention and Infection Control, Geneva) The Role of Patients and Patient Associations in Improving Infection Prevention Strategies and Policies
Speaker: Prof Didier Pittet, Sir Liam Donaldson, World Health Organization
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