Reducing Spread of Pathogens by Environmental Surfaces in Healthcare

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REDUCING SPREAD OF PATHOGENS BY ENVIRONMENTAL SURFACES IN HEALTHCARE: HAVE WE ADVANCED IN THE LAST 10 YEARS?

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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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DISINFECTANT USE

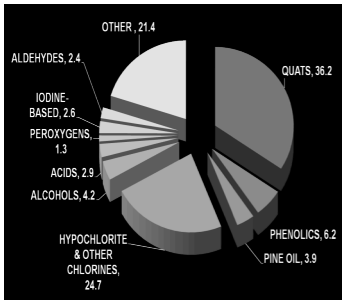
->5,000 REGISTERED DISINFECTANTS IN THE U.S.

->60% USED AGAINST HUMAN PATHOGENS

-ABOUT 275 DIFFERENT TYPES OF ACTIVES

-ANNUAL SALES OF >BILLION DOLLARS & INCREASING

DISINFECTANTS USED IN I&I IN THE U.S.
(MODIFIED FROM FU ET AL., 2007



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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

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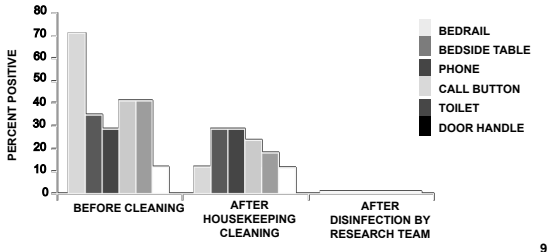
% OF VRE-POSITIVE CULTURES FROM 17 ROOMS TESTED

(Eckstein *et al.*, BMC Infect. Dis. 2007;7:61)

DISINFECTION WITH 10% DOMESTIC BLEACH BY HOUSE-KEEPING STAFF STILL LEFT MANY SURFACES CONTAMINATED; ADDITIONAL IN-SERVICE TRAINING WAS REQUIRED TO IMPROVE THE PRACTICE.



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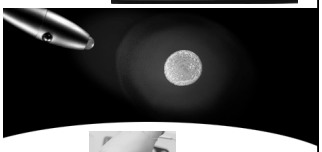
FLUORESCENT MARKING TOOL

- **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**



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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!

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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)

LIST #	TYPE OF PATHOGEN(S)	NO. OF PRODUCTS
B	***MYCOBACTERIUM TUBERCULOSIS***	164
C	**HUMAN IMMUNODEFICIENCY VIRUS TYPE 1 (HIV-1)**	486
D	**HIV-1 & HEPATITIS B VIRUS**	176
E	**HEPATITIS C VIRUS**	127
F	**NOROVIRUS (NORWALK-LIKE VIRUS)**	50
H	**METHICILLIN RESISTANT *STAPHYLOCOCCUS AUREUS* (MRSA) ONLY**	32
	VANCOMYCIN RESISTANT *ENTEROCOCCUS FAECALIS* OR *FAECIUM* (VRE) ONLY	11
	MRSA & VRE	202

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CLOSTRIDIUM DIFFICILE

- A GOOD EXAMPLE OF IMPROVEMENTS IN THE PAST DECADE
  - LABEL CLAIMS WERE BASED ON VEGETATIVE CELLS
  - CAMPAIGN FOR CHANGE IN REGULATIONS SUCCESSFUL
- GUIDANCE DOCUMENT FROM EPA TO TEST AGAINST SPORES
  - NO SOIL LOAD REQUIRED
- PRODUCTION OF HIGH TITRES (>10^9 CFU/mL) OF VIABLE SPORES (HASAN ET AL., 2011; PEREZ ET AL., 2011)
  - SOON TO BE STANDARDS OF ASTM INTERNATIONAL
- AOAC INTERNATIONAL'S EXPERT REVIEW PANEL ON SPORE PRODUCTION & TESTING SPORICIDAL ACTIVITY
  - SOIL LOAD TO BE INCLUDED
- SEVERAL SPORICIDAL PRODUCTS NOW ON THE MARKET

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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
  - HOUSE-KEEPING STAFF IS BETTER TRAINED & RECOGNIZED

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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/ CM^2
- NO SUITABLE METHOD TO TEST ROLE OF WIPING

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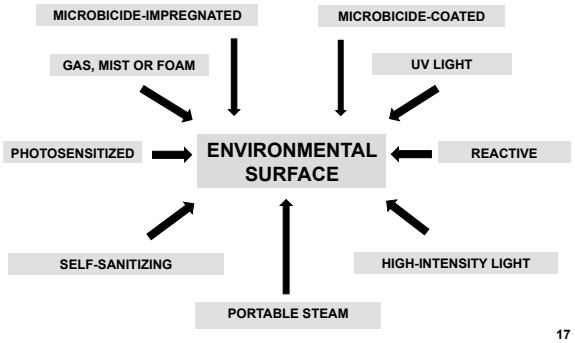
NEWER WAYS TO DECONTAMINATE HARD, NON-POROUS ENVIRONMENTAL SURFACES



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NEWER TECHNOLOGIES FOR DECONTAMINATION OF ENVIRONMENTAL SURFACES

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

GASES, MISTS & FOAMS

- MANY ESTABLISHED & NEWER TECHNOLOGIES
  - H_2O_2 & CHLORINE DIOXIDE
  - CANADIAN AQUEOUS SYSTEM FOR CHEMICAL/BIOLOGICAL AGENT DECONTAMINATION (CASCAD) 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

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OZONE

- **PURE OZONE (≤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 H_2O_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**

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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

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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?

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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

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REACTIVE 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 (BROVKO 2010)

- **TREATMENT OF FOOD-CONTACT SURFACES WITH NON-TOXIC DYES FOLLOWED BY EXPOSURE TO LIGHT**

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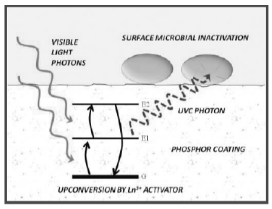
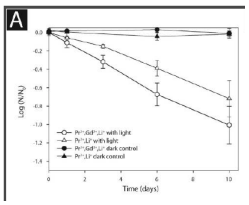
UPCONVERTING VISIBLE LIGHT INTO UVC (220-280 NM)
(CATES ET AL. 2011)

- 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





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UV IRRADIATION (NERANDZIC 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

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HIGH-INTENSITY LIGHT
(MACLEAN ET AL., 2010)

- 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?

http://medgadget.com/archives/2010/11/high_intensity_narrow_spectrum_light_for_continuous_environmental_disinfection.html

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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
- ELECTICAL SUPPLY ESSENTIAL
- MATERIALS COMPATIBILITY?
- FEASIBILITY OF USE ON LARGE SURFACE AREAS?

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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**

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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'

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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

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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 Preparation** **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** **Sponsor: Virox Technologies Inc (www.virox.com)**

www.webbertraining.com/schedulep1.php