DISINFECTION OF ENVIRONMENTAL SURFACES: CAN IT BE MADE BETTER AND SAFER?

SYED A. SATTAR, Ph.D.
CENTRE FOR RESEARCH ON ENVIRON. MICROBIOLOGY (CREM)
UNIVERSITY OF OTTAWA, OTTAWA, ONTARIO, CANADA

ACKNOWLEDGEMENTS

CHICA
JACKIE BOSC (TRAVEL)
GERRY HANSEN
LINDA KINGSBURY
KELLI WAGNER
VIROX
NICOLE KENNY
CENTRE FOR RES. ON ENVIRON. MICROBIOL.
STAFF & STUDENTS

DISCLOSURE (PAST TWO YEARS)

PERSONAL
MEMBER, BOARD OF DIRECTORS, VIROX TECH, OAKVILLE, ON
TECHNICAL ADVISOR TO STERIS CORP. (MENTOR, OH), KIMBERLY-CLARK (ROSWELL, GA); VIROX TECH
CREM - RESEARCH STUDY CONTRACTS:
CALTECH INDUSTRIES (MIDLAND, MI); DEB GROUP (DERBYSHIRE, UK); LERNAPHARM (MONTREAL, QC); GOJO INDUSTRIES (AKRON, OH); PROCTOR & GAMBLE CO (CINCINNATI, OH); UMF CORP. (CHICAGO, IL); VIROX TECH
ADVISORY SERVICES
WORLD HEALTH ORGANIZATION
ORGANIZATION FOR ECONOMIC CO-OP & DEVELOPMENT
AOAC INTERNATIONAL
GOVT. OF CANADA
INTERNATIONAL CIVIL AVIATION ORGANIZATION
NO SPECIFIC PRODUCT OR SERVICE TO BE MENTIONED
OBJECTIVES

- PREVENTIVE STRATEGIES
- CLEANING & DISINFECTION
- USE OF CHEMICALS AS DISINFECTANTS
- WIPE TESTING OF DISINFECTANTS
- THE ‘GREEN’ MOVEMENT
- CONCLUDING REMARKS

INFECTIOUS DISEASE SPREAD
(MODIFIED FROM WORLD HLTH. REP., 1996)

- AIR, PERSON-TO-PERSON, ENVIRON, SURFACES, MED. DEVICES, 65%
- FOOD & WATER, 22%
- ANIMALS, 0.30%
- INSECTS, 13%

ENVIRONMENTAL SPREAD IN HEALTHCARE SETTINGS (SATTAR)

SOURCE OF PATHOGEN

- ENVIRON. SURFACES
- WATER
- FOOD
- INSECTS

INFECTION

- MEDICAL DEVICES
- HANDS
- ANIMALS

SUSCEPTIBLE HOST
INTERRUPTING SPREAD OF PATHOGENS

- **GENERAL MEANS**
  - Vaccination of Humans (Polio) & Animals (Rabies)
  - Chemotherapy (Antibiotics)
  - Disease Surveillance (TB), Quarantine (Rabies), Barrier Protection (AIDS), Screening of Blood & Tissues (Hep. B), Education (Toxoplasmosis)

- **ENVIRONMENTAL MEANS**
  - Cleaning
  - Antisepsis
  - Disinfection
  - Sterilization

INTERRUPTING THE ENVIRONMENTAL SPREAD OF PATHOGENS

- **PATHOGEN**
  - Contamination
  - Survival
  - Transfer to other vehicles
  - Inoculation
  - Infection (Disease)
  - Interruption

DISINFECTANT USE

- >5,000 Registered Disinfectants in U.S.
- >60% for use against human pathogens
- About 275 different types of actives
- Annual sales of >billion dollars & increasing
- Differences in registration requirements

DISINFECTANTS USED IN I&I IN THE U.S. (MODIFIED FROM FU ET AL. 2007)
IS THERE ANY SCIENTIFIC BASIS FOR ENVIRONMENTAL DECONTAMINATION FOR HIGH-PROFILE PATHOGENS?

- Frequently, label claims made for activity against pathogens such as HIV, SARS virus, and avian flu
- Lack of evidence for their spread via contaminated environmental surfaces
- Therefore, caution recommended in requiring & accepting such claims
- Requests for such claims from ICP create undue pressure for manufacturers & testing labs

DOES HOUSE-KEEPING STAFF HAVE SKILLS & TRAINING FOR OPTIMAL DISINFECTION OF ENVIRONMENTAL SURFACES?

- A crucial but weak-link in the chain
- Least skilled & trained with fast turn-over
- Directions for storage, dilution, application & disposal may be difficult to interpret
- Language often a barrier
- In-service training could be better
- Urgent need to address these issues

CONTAMINATED SURFACES IN U.S. HOSPITALS* (P. CARLING, MAY 2008)

<table>
<thead>
<tr>
<th>Surface</th>
<th>VRE</th>
<th>MRSA</th>
<th>C. DIFFICILE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bed rails</td>
<td>+++</td>
<td>*</td>
<td>***</td>
</tr>
<tr>
<td>Bed table</td>
<td>+++</td>
<td>*</td>
<td>-</td>
</tr>
<tr>
<td>Door knob</td>
<td>++</td>
<td>++</td>
<td>-</td>
</tr>
<tr>
<td>Doors</td>
<td>+++</td>
<td>*</td>
<td>-</td>
</tr>
<tr>
<td>Call button</td>
<td>+++</td>
<td>*</td>
<td>-</td>
</tr>
<tr>
<td>Chair</td>
<td>+++</td>
<td>*</td>
<td>++</td>
</tr>
<tr>
<td>Tray table</td>
<td>+++</td>
<td>++</td>
<td>-</td>
</tr>
<tr>
<td>Toilet surface</td>
<td>*</td>
<td>-</td>
<td>****</td>
</tr>
<tr>
<td>Sink surface</td>
<td>+</td>
<td>+</td>
<td>***</td>
</tr>
<tr>
<td>Bedpan cleaner</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*Data from 23 separate studies

SYED A. SATTAR
CHICA CONFERENCE, VANCOUVER, MAY-JUNE 2010

% OF C. DIFFICILE-POSITIVE CULTURES FROM 9 ROOMS TESTED
(Eckstein et al., BMC Infect. Dis. 2007;7:61)

Disinfection with 10% domestic bleach by housekeeping staff still left many surfaces contaminated; additional in-service training was required to improve the practice.

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

Ways of applying microbicides on environmental surfaces:
- Flood
- Spray & Wipe
- Dip & Wipe
- Spray & Dry
- Wipe – Prewetted Applicator
- Gas, Fog, Foam
WIPING & VOLUME OF LIQUID TRANSFERRED*

<table>
<thead>
<tr>
<th></th>
<th>SQUEEZED AT NORMAL PRESSURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>VERY WET (DRAINED, NOT DRIPPING, NOT SQUEEZED)</td>
<td>1.78 ± 0.29 µL/cm²</td>
</tr>
<tr>
<td></td>
<td>0.26 ± 0.03 µL/cm²</td>
</tr>
<tr>
<td></td>
<td>14.9 – 20.7 mL/m²</td>
</tr>
<tr>
<td></td>
<td>2.3 – 2.9 mL/m²</td>
</tr>
</tbody>
</table>

*SATTAR ET AL., UNPUBLISHED DATA

WHICH ENVIRONMENTAL SURFACES SHOULD BE TARGETS FOR REGULAR DECONTAMINATION?

- **Principal consideration** is *potential of a given surface to harbor & donate pathogens during routine contact*

- **Must include:**
  - Probability of contamination with pathogens
  - Ability to allow for pathogen survival
  - Ease of pathogen release
  - Location & frequency of direct contact with hands or mucous surfaces

ARE CURRENT ENVIRONMENTAL SURFACE DISINFECTANTS & THEIR APPLICATION OPTIMAL FOR INFECTION PREVENTION?

- **Many common products** are no more than weak bactericides (low-level disinfectants)
- **Their field application** further compromises their activity due to:
  - Much shorter contact times
  - Often minute volumes applied to surfaces
  - High soil load
- This generates a false sense of security
- May in fact increase risk of pathogen spread!
CAN OTHER MEANS HELP REDUCE RISK OF PATHOGEN SPREAD FROM ENVIRONMENTAL SURFACE?
- USE OF MICROFIBER-BASED FABRICS IN DISINFECTION OF ENVIRONMENTAL SURFACES SHOWS MUCH PROMISE
- UV LIGHT WITH OR WITHOUT H.E.P.A. FILTRATION
- USE OF GASEOUS CHEMICALS & FOGGING
- TITANIUM OXIDE & UV LIGHT

ARE DETERGENTS ALONE A BETTER ALTERNATIVE TO DISINFECTANTS?
- THEY ARE WEAK MICROBICIDES & CAN SPREAD MICROBIAL CONTAMINATION OVER A WIDER AREA DURING CLEANING
- BACTERIA CAN ALSO GROW IN IN-USE DILUTIONS OF MANY DETERGENTS & THIS MAY LEAD TO INADVERTENT & WIDER SPREAD OF MICROBIAL CONTAMINATION
- MANY SYNTHETIC DETERGENTS MAY NOT BE AS SAFE FOR AQUATIC LIFE AS PREVIOUSLY THOUGHT
- LACK OF COMPATIBILITY BETWEEN DETERGENTS & DISINFECTANTS (E.G., ANIONIC DETERGENTS & QUATS)

IS GOVERNMENT REGISTRATION ENOUGH TO CONSIDER A GIVEN PRODUCT EFFECTIVE?
- NOT WHEN IT COMES TO MOST ENVIRONMENTAL SURFACE DISINFECTANTS!
- THIS IS BECAUSE OF OUTDATED REGISTRATION REQUIREMENTS & FLAWED TEST METHODS
- ANOTHER WEAK-LINK
- MATERIALS MANAGERS & ICPs MAY NOT BE TRAINED ENOUGH TO EXERCISE JUDGMENT HERE
- A REVIEW OF THIS ISSUE IS URGENTLY NEEDED
MICROBICIDES ARE A DOUBLE-EDGED SWORD

- No chemical that can kill microbes can be totally safe for other life forms.
- However, some microbicidal chemicals can be more toxic than others.
- Challenge is to promote development & application of safer ones.
- Use more harmful ones in ways to optimize their desirable attributes while minimizing their undesirable traits.

THE 'ALARA' PRINCIPLE

- Adopt the ALARA (as low as reasonably achievable) principle from radiation safety in dealing with microbicides.
- Entails making every reasonable effort to maintain worker & patient exposures to harmful chemicals as low as possible.
- Would require:
  - Better education & training of end-users
  - Introduction of safer products & procedures
  - A more reasoned approach to using microbicides in infection control

WHAT IS 'GREEN' OR SUSTAINABLE CHEMISTRY?

- Environmentally-friendly chemicals/processes that reduce waste while producing safer products with less use of energy.
- Promotes renewable starting materials for a bio-based economy.
THE ‘GREEN’ MOVEMENT

- House-hold chemicals as cleaners
- Disinfectant activity too slow & limited
- Potential toxicity of botanicals
- Criteria for ‘green’ chemistry (Table)
- Persistent chemicals to be discouraged

PRINCIPLES OF ‘GREEN CHEMISTRY’

1. Design safer chemicals & products that are fully effective with little or no toxicity
2. Use safer solvents & 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

CONCLUSIONS

- Products/procedures in use for disinfection of environmental surfaces need review
- Many formulations have limited microbicidal activity
- The contact time on labels too long!
- Such chemicals potentially toxic & damaging
- Better, faster-acting & safer microbicides needed
- Wipe testing to be refined & promoted
- Sub-lethal exposures to microbicides unwise – potential for microbicidal & antibiotic resistance

Thank you!