
Disinfection and Antisepsis: Special Emphasis on Pediatric Issues

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Disinfection and Antisepsis: Special Emphasis in Pediatrics

- Toys (reusable) and books
- Devices-alligator clamps, rhinoscopes, tympanogram tips, reusable otoscope tips, nasal tongs, nasal speculums, laser distance guide tips (Dermatology), thermometers, stethoscopes, BP cuffs, keyboards, call button devices
- Viral pathogens (rotavirus, norovirus, adenovirus)
- CF patients and *B. cepacia* + *S. maltophilia*
- Glucometers
- Pet Therapy
- Hand hygiene: antimicrobial soap vs regular lotion soap vs alcohol hand rubs
- Washing machines
- Quats vs phenolics in pediatrics
- Pediatric Biological Response Plan

disinfectionandsterilization.org

Disinfection and Sterilization

EH Spaulding believed that how an object will be disinfected depended on the object's intended use.

CRITICAL - objects which enter normally sterile tissue or the vascular system or through which blood flows should be **sterile**.

SEMICRITICAL - objects that touch mucous membranes or skin that is not intact require a disinfection process (**high-level disinfection[HLD]**) that kills all microorganisms but high numbers of bacterial spores.

NONCRITICAL -objects that touch only intact skin require **low-level disinfection**.



Processing “Critical” Patient Care Objects

Classification:	Critical objects enter normally sterile tissue or vascular system, or through which blood flows.
Object:	Sterility.
Level germicidal action:	Kill all microorganisms, including bacterial spores.
Examples:	Surgical instruments and devices; cardiac catheters; implants; etc.
Method:	Steam, gas, hydrogen peroxide plasma or chemical sterilization.

Critical Objects

- Surgical instruments
- Cardiac catheters
- Implants

Chemical Sterilization of “Critical Objects”

Glutaraldehyde ($\geq 2.0\%$)

Hydrogen peroxide-HP (7.5%)

Peracetic acid-PA (0.2%)

HP (1.0%) and PA (0.08%)

HP (7.5%) and PA (0.23%)

Glut (1.12%) and Phenol/phenate (1.93%)

Exposure time per manufacturers' recommendations



Processing “Semicritical” Patient Care Objects

Classification:	Semicritical objects come in contact with mucous membranes or skin that is not intact.
Object:	Free of all microorganisms except high numbers of bacterial spores.
Level germicidal action:	Kills all microorganisms except high numbers of bacterial spores.
Examples:	Respiratory therapy and anesthesia equipment, GI endoscopes, thermometer, etc.
Method:	High-level disinfection

Semicritical Items

- Endoscopes
- Respiratory therapy equipment
- Anesthesia equipment
- Endocavitary probes
- Tonometers
- Diaphragm fitting rings

High Level Disinfection of “Semicritical Objects”

Exposure Time \geq 12 m-30m, 20°C

Germicide	Concentration
Glutaraldehyde	$\geq 2.0\%$
Ortho-phthalaldehyde (12 m)	0.55%
Hydrogen peroxide*	7.5%
Hydrogen peroxide and peracetic acid*	1.0%/0.08%
Hydrogen peroxide and peracetic acid*	7.5%/0.23%
Hypochlorite (free chlorine)*	650-675 ppm
Glut and phenol/phenate**	1.21%/1.93%

*May cause cosmetic and functional damage; **efficacy not verified



Processing “Noncritical” Patient Care Objects

Classification:	Noncritical objects will not come in contact with mucous membranes or skin that is not intact.
Object:	Can be expected to be contaminated with some microorganisms.
Level germicidal action:	Kill vegetative bacteria, fungi and lipid viruses.
Examples:	Bedpans; crutches; bed rails; EKG leads; bedside tables; walls, floors and furniture.
Method:	Low-level disinfection

Low-Level Disinfection for “Noncritical” Objects

Exposure time \geq 1 min

Germicide

Use Concentration

Ethyl or isopropyl alcohol

70-90%

Chlorine

100ppm (1:500 dilution)

Phenolic

UD

Iodophor

UD

Quaternary ammonium

UD

UD=Manufacturer's recommended use dilution

Disinfectants for Surface Disinfection Controversy

- Noncritical Surfaces
 - Medical equipment surfaces (BP cuff, stethoscopes)
 - ◆ May frequently become contaminated with patient material
 - ◆ Repeatedly touched by health care personnel
 - ◆ Disinfectant/detergent should be used
 - Housekeeping surfaces (bed rails, bedside tables)
 - ◆ May play a theoretical but less significant role in diseases transmission
 - ◆ Disinfectants/detergents may be used (II) and detergents (non-patient care areas)

Use of Disinfectants for Noncritical Items/Surfaces

- Disinfect noncritical medical equipment with disinfectant at the proper use-dilution and a contact time of at least 1 min
- Frequency for disinfecting items/surfaces should comply with facility policies and minimally when visibly soiled and on a regular basis
- Disinfect noncritical patient-care items if used on a patient on Contact Precautions before use by another patient

Phenolics in Nurseries

- Use of phenolics questioned due to hyperbilirubinemia in infants placed in bassinets where phenolics were used
- If phenolics are used to clean nursery floors, they must be diluted according to the recommendation on the product label
- Phenolics (and other disinfectants) should not be used to clean infant bassinets and incubators while occupied
- If phenolics are used to terminally clean infant bassinets and incubators, the surfaces should be rinsed thoroughly with water and dried before the infant bassinets and incubators are reused

Disinfection and Sterilization of Emerging Pathogens

Disinfection and Sterilization of Emerging Pathogens

- Hepatitis C virus
- *Clostridium difficile*
- *Cryptosporidium*
- *Helicobacter pylori*
- *E.coli* 0157:H7
- Antibiotic-resistant microbes (MDR-TB, VRE, MRSA)
- SARS Coronavirus, norovirus, avian influenza
- Bioterrorism agents (anthrax, plague, smallpox)

Disinfection and Sterilization of Emerging Pathogens

Standard disinfection and sterilization procedures for patient care equipment are adequate to sterilize or disinfect instruments or devices contaminated with blood and other body fluids from persons infected with emerging pathogens

Noroviruses

- Norovirus (formerly Norwalk-like viruses) is a genus within the family Caliciviridae
- Causes acute gastroenteritis in humans
- Outbreaks have been reported in hospitals, homes, camps, schools and cruise ships
- Outbreaks in hospitals have increased in recent years and this may lead to the closure of wards
- This group of viruses cannot be grown in cell culture so feline calicivirus used as a surrogate

Inactivation of Feline Caliciviruses

Sattar SA. J Hosp Infect 2004;56:S64

Disinfectant	Log Reduction	Contact Time (min)
Accel HP (5000 ppm)	>4.7	3
Chlorine dioxide (1000 ppm)	4.5	1
Chlorine (1000 ppm)	>4.5	1
QUAT	4.0	10
75% Ethanol	4.7	10

Rotavirus

Role of Environment Surfaces in Transmission

Sattar et al. J Hyg Camb 1986;96:277

- Rotaviruses are known as cause of outbreaks of diarrhea
- Excreted in large numbers in feces of infected individuals at least 5 days and remain viable for prolonged periods
- At 22°C and non-porous surfaces, >99% reduction at high relative humidity (85%) in 2 days but survives for 12 days at 25 and 50% RH
- Virus survival on porous surfaces (cloth, paper currency, poster card) was variable

Rotavirus Inactivation by Disinfectants

Rutala WA. CDC Guideline for D/S. In press

- 95% ethanol, 70% isopropanol, some phenolics, 2% glutaraldehyde, 0.35% peracetic acid, and some quaternary ammonium compounds have demonstrated efficacy ($>3 \log_{10}$ reduction in virus) against rotavirus within 1 minute.
- In a human challenge study, a disinfectant spray (0.1% ortho-phenylphenol and 79% ethanol), sodium hypochlorite (800 ppm free chlorine), and a phenol-based product (14.7% phenol diluted 1:256 in tapwater) when sprayed onto contaminated stainless steel disks, were effective in interrupting the transfer of a human rotavirus from stainless steel disk to fingerpads of volunteers after an exposure time of 3 to 10 minutes. A quaternary ammonium product (7.05% quaternary ammonium compound diluted 1:128 in tapwater) and tapwater allowed transfer of virus.

Adenovirus

Role of Environment Surfaces in Transmission

Sattar et al. *Epidem. Inf.* 1989;102:493; Rutala et al. submitted for publication

- Adenovirus are a known cause of epidemic keratoconjunctivitis
- Extremely hardy and recovered from plastic and metal surfaces for more than 30 days
- >1500 ppm chlorine, 70% ethanol, 2% glutaraldehyde, 0.2% peracetic acid and OPA have demonstrated efficacy ($>3 \log_{10}$ reduction in virus) against adenovirus within 1-5 minutes
- Quaternary ammonium compounds, iodophor, CHG, a phenolic, 70% isopropyl alcohol, 3% hydrogen peroxide, 1-5% chloroxylenol were not effective

Frequency of ARB at UNCHCS CF Population

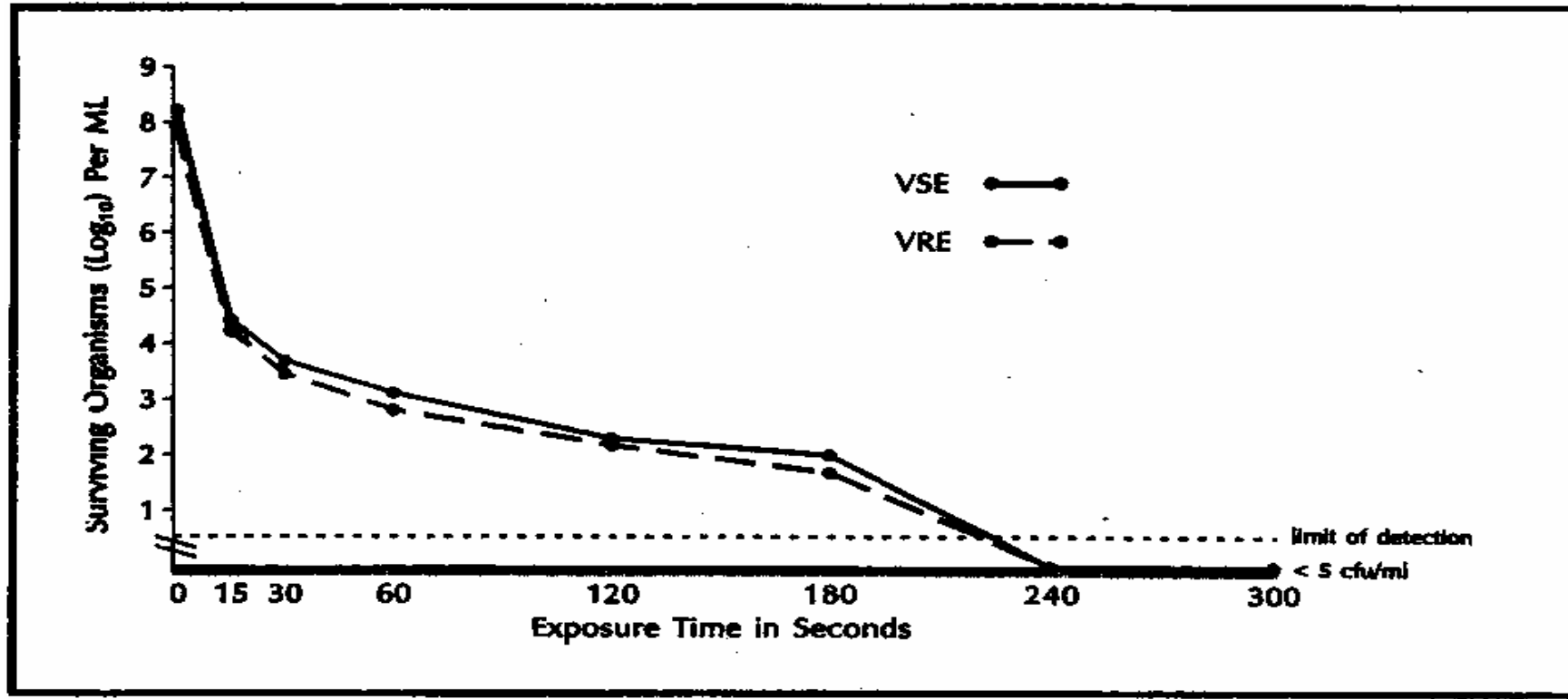
	Number Patients	<i>B. cepacia</i>	ORSA	MDR <i>P. aeruginosa</i>	Total Resistant
Adult	158	11%	17%	25%	48%
Pediatric	234	2%	18%	9%	28%
Total	392	6%	18%	15%	36%

SUSCEPTIBILITY OF VRE TO DISINFECTANTS

- Purpose of experiment
 - To determine susceptibility of VRE and VSE to various concentrations of commonly used hospital disinfectants (iodophor, quat, phenolic)
- Methods
 - Microbial suspension test to determine \log_{10} reduction
 - Exposure periods: 15 and 30 sec, then 1 min intervals for 5 minutes

Anderson R, et al. ICHE 1997;18:195-199.

VRE AND VSE SUSCEPTIBILITY TO A QUAT



SUSCEPTIBILITY OF VRE TO DISINFECTANTS

- Results
 - Survival curves demonstrated no difference between the VRE and VSE strains
- Conclusion
 - VRE and VSE are sensitive to a spectrum of commonly used hospital disinfectants and have parallel inactivation rates
 - No relationship between antibiotic-susceptible and antibiotic-resistant strains and resistance to disinfectants

Patients with Cystic Fibrosis

- Adopted the Cystic Fibrosis Foundation guidelines (AJIC 2003;31:1-52).
 - Follow published recommendations such as clean before HLD or sterilization
 - Dedicate noncritical patient care equipment to patients on Contact Precautions and disinfect before use on another patient
 - Disinfect environmental surfaces contaminated with respiratory secretions such as during pulmonary function testing

Disinfecting Pediatric Items

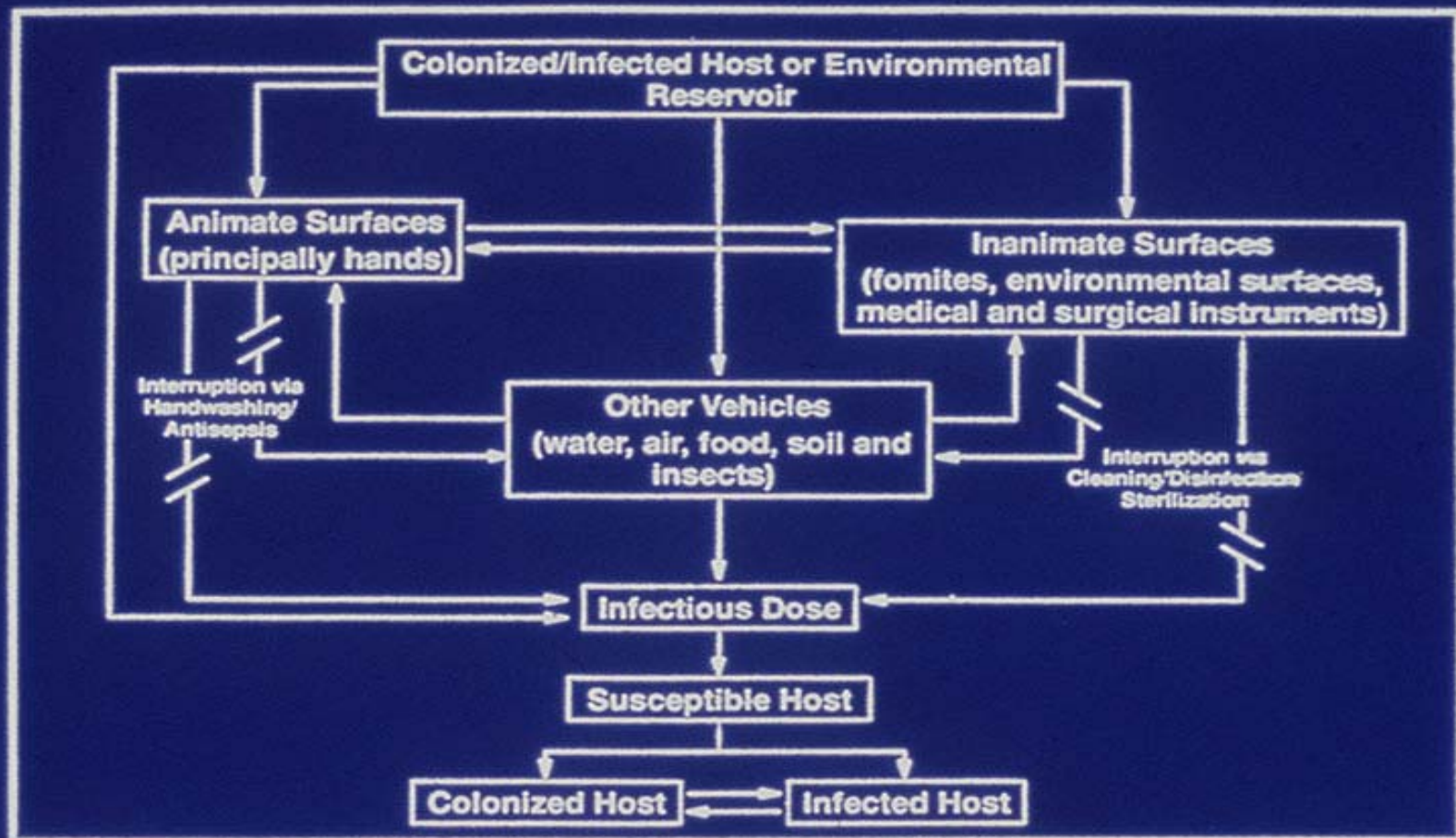


FIGURE. Transmission of infectious agents via animate and inanimate surfaces (modified from reference 25).

Bacterial Colonization of Toys in NICU Cots

Pediatrics 2000;106:E18

- Over 4-week period, there were 86 cultures from 34 toys of 19 infants
- Bacteria were grown from 84/86 (98%), many were potentially pathogenic (84 CONS, 13 MRSA, 4 GBS)
- Study demonstrated nearly all toys in NICU incubators/cots are contaminated with bacteria
- No direct evidence that bacteria on toys cause infection
- Concern that nearly all toys contaminated with bacteria

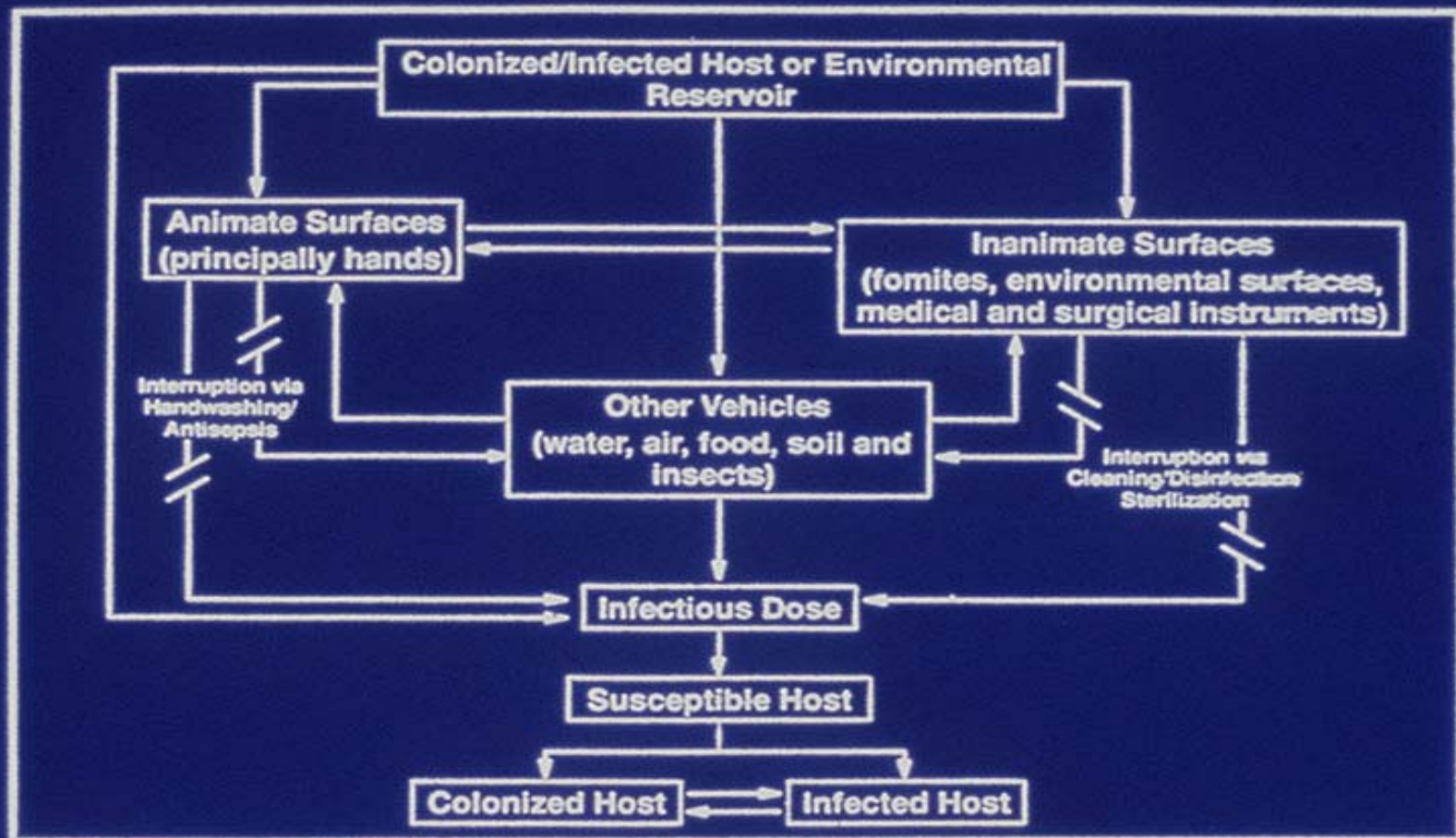


FIGURE. Transmission of infectious agents via animate and inanimate surfaces (modified from reference 25).

Toys

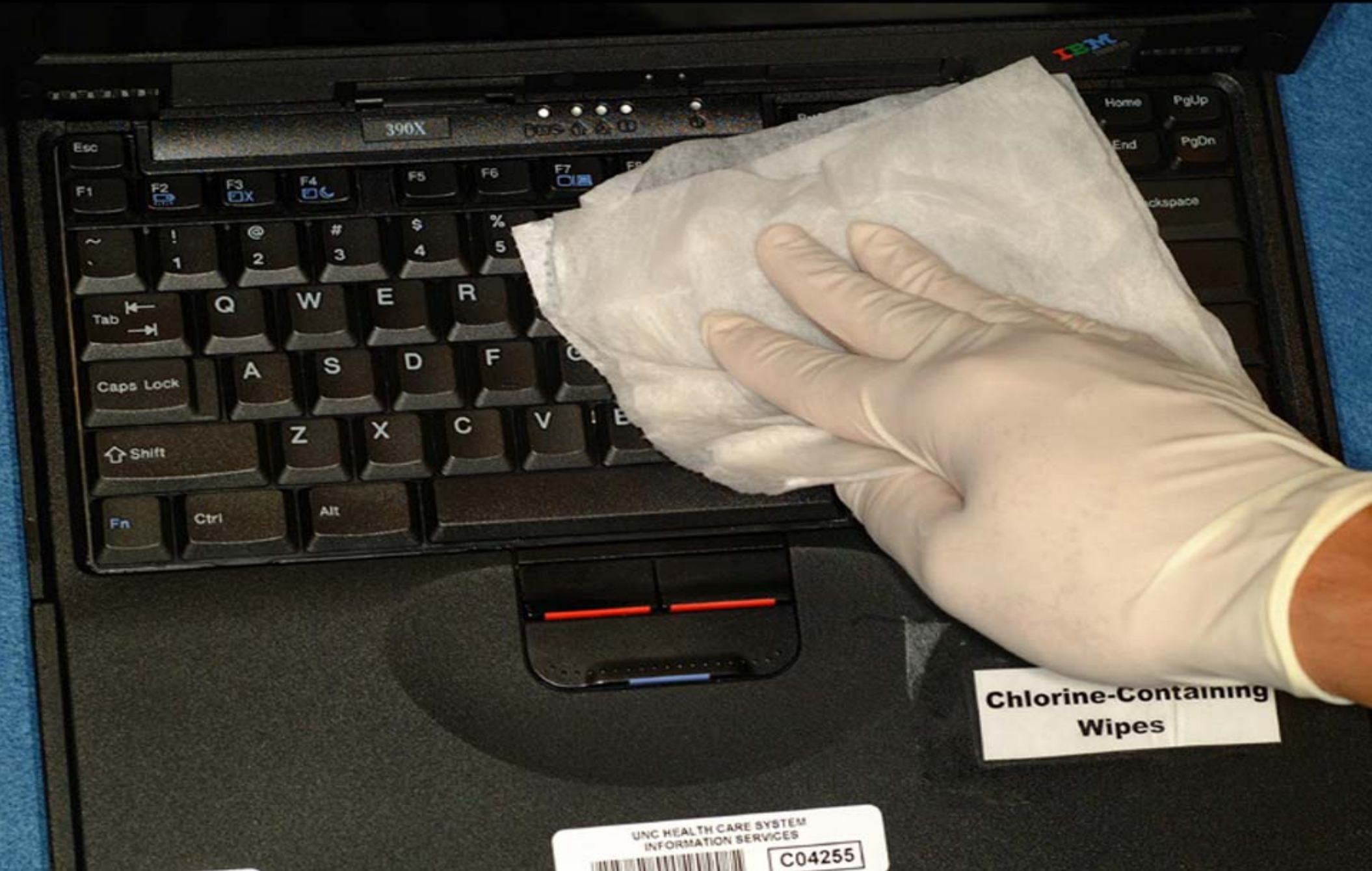
- Items used by younger children (who have a tendency to put things in their mouth) should be made of washable material
- Used washable toys are cleaned with soap and water and rinsed with tapwater, or wiped with 70% alcohol when soiled
- Non-washable toys (puzzles, puppets) may be used by older children
- Non-washable toys are gas sterilized or disposed of when soiled
- New toys brought into the play areas do not need to be sterilized or disinfected

Toys

- Toys that are not washable should not be taken into the room of a patient on Isolation Precautions unless they can be gas sterilized. Preferably, the child should have his own toys or be given toys he can keep.
- Washable toys used by a patient on Isolation Precautions should be washed with soap and water followed by 70% alcohol before being returned to the play areas for use by other children
- Washing plastic/vinyl toys in the dishwasher with chlorine bleach detergent is acceptable, on the hottest water setting

Toys

- Playing cards should be decontaminated using a disinfectant, stored for six months, or sterilized
- Games, puzzles, and books that cannot be disinfected, stored for six months, or sterilized should be given to the patient
- Pool table felt does not have to be disinfected, but cue sticks, balls, chalk, and racking triangle will be disinfected



**Chlorine-Containing
Wipes**

UNC HEALTH CARE SYSTEM
INFORMATION SERVICES

C04255

Disinfection of Computer Keyboards

- Increased use of computers in patient areas has led to contamination of keyboards as reservoirs of pathogens
- Study performed to
 - Examine the efficacy of different disinfectants on the computer keyboard
 - Determine if there were cosmetic (key lettering removed) or functional changes after 300 wipes



SANIWIPE



0 WIPES



300 WIPES

Disinfection of Computer Keyboards

- All tested products were effective (>95%) in removing and/or inactivating the test pathogens (MRSA, *P. aeruginosa*). No functional/cosmetic damage.
- Disinfectants included: 3 quaternary ammonium compounds, 70% isopropyl alcohol, phenolic, chlorine (80ppm)
- At present, recommend that keyboards be disinfected daily (for 5 sec) and when visibly soiled

Computers

- Mobile computers used by patients must be disinfected between patient uses.
- Computers used by patients on Isolation Precautions must have the computer remain in their rooms until no longer needed. The computer is disinfected before use by another person.
- Computers located in patient care areas should be managed in a clean manner. Computers should be disinfected daily and when visible soiled.
- Computers should not be taken into rooms of patients on Contact Precautions but if it is, it should be disinfected prior to use.



Removal of VRE by Laundry Cycle

Rutala WA et al. Unpublished data

- Inoculated sheets/towels with 10^9 VRE
- Used regular cycle, heavy wash, normal rinsing, regular detergent (Tide), no chlorine, hot/cold vs cold/cold, side loading vs top loading
- Top loading unit resulted in complete removal of VRE from the inoculated sheets/towels and the machine
- Side loading unit resulted in significant reduction of VRE (~45% no growth) from the inoculated sheets/towels and the machine but low-level contamination (5-104 Rodac per inoculated sheet). Chlorine rinse of the tub which removed bacteria.



HBV and Blood Glucose Monitoring

- Three outbreaks of HBV in LTC associated with glucose monitoring (MMWR; 2005:54-220)
- Assign separate glucometers to individual patients. If a glucometer must be reused for another patient, the exterior surfaces of the device must be disinfected.
- Disinfect with disinfectant with TB or HBV/HIV claim, or a dilute bleach solution of 1:10-1:100 concentration.
- Directions vary by manufacturer: alcohol damages light emitting diodes (LED) readout; QUATs may damage metal parts.



ENT Equipment

- Reusable ear and nasal specula, reusable otoscope tips and nasal tongs are washed with detergent and water and then autoclaved after each patient. Alternatively, disposable speculae may be used. Curettes (used to clean the ear canal of ear wax) should be cleaned in the same manner.
- Non-disposable rubber tips on audioscopes/tympanometers should be washed in soap and water, immersed in glutaraldehyde for 20 minutes, rinsed and allowed to dry
- Rhinoscopes should be HLD

Equipment

- Shared equipment that has contact with the patient's intact skin must be cleaned between uses on different patients. An EPA-approved disinfectant or 70% alcohol should be used.
- If shared equipment is taken into the Isolation Room, it is best to leave it with the patient until no longer needed.
- If removed from the Isolation Room, it should be thoroughly cleaned with soap and water (if visibly soiled) and wiped with EPA-registered disinfectant or 70% alcohol

Commonly Shared Patient Equipment

Inpatient Care

- Monitor leads, transducer cables, dopplers, skin probes, alligator clamps, nondisposable blood pressure cuffs are cleaned with 70% alcohol, a bleach solution, or a phenolic when obviously soiled and between use for different patients
- Rolling blood pressure monitors should be disinfected daily, after use on nonintact skin, after use with a patient on Contact Precautions and when visibly soiled
- Infusion pumps, monitors and IV poles are disinfected with a bleach or phenolic solution at least weekly and between use for different patients

Commonly Shared Patient Equipment

Inpatient Care

- Scales are disinfected on a routine basis (e.g., weekly), when obviously soiled and after use for a patient on Contact Precautions
- Electronic thermometer probe unit and cord are disinfected daily and when visibly soiled with a 70-90% alcohol single-use pledget.

Fisk Tanks and Water Gardens

- Fish tanks are allowed with the following strict precautions (Recreational Therapy):
 - They are inaccessible to patients (enclosed area with observation window; freestanding tank with a solid, affixed top)
 - They are not managed by health care workers, but by a contracted service provider
 - All patients may participate in feeding the fish but must wash their hands before and after the feeding and be supervised by a therapist during the activity
- No tabletop waterfalls/water gardens are allowed in patient care areas

Visitation by Children

- All visitors must be free of communicable diseases
- Children (<12) screened for illness prior to visitation in the ICUs, step down units, Burn Center, L&D, PACU and the Bone Marrow Unit is required
- MD or designee responsible for assessing at each daily visit whether child represents a risk of transmission
- Child screened for the presence within 24 hours of the following: fever, cough, sore throat, runny nose, conjunctivitis, vomiting, diarrhea, skin rash, and boils. Assessed for exposure to chickenpox, pertussis, etc within the past 3 weeks.



Animal-Assisted Therapy

- Avoid selection of nonhuman primates and reptiles
- Enroll animals that are vaccinated, healthy, clean and negative for enteric parasites
- Ensure animals are trained
- Restrict resident animals in patient care areas
- Use routine cleaning protocols for housekeeping surfaces
- Establish policy for cleaning cages and assign to non-patient-care staff member

Service Animals

- Avoid providing access to nonhuman primates and reptiles as service animals
- Allow service animals access in accordance with ADA, unless the presence of the animal creates a direct threat to other persons or change in nature of the services
- When considering service animals access, evaluate the animal/patient/situation on a case-by-case basis to determine risk of harm and how to mitigate
- If patient separated from animal, must address patient's needs

We Have A Duty To Be Prepared



- Potential Agents (anthrax, botulism, plague, smallpox)
 - Epidemiologic features-transmission, case
 - Infection control practices for patient management-isolation, hand hygiene, PPE, patient placement, patient transport, D/S of equipment and surfaces, discharge management
 - Post exposure management-decontamination of patients and environment, prophylaxis, psychological aspects
 - Laboratory support-diagnostic samples, transport requirements
 - Patient, visitor and public information





Guideline for Hand Hygiene in Healthcare Settings, 2002

JM Boyce, D Pittet, HICPAC/SHEA/APIC/IDSA
Hand Hygiene Task Force

Hand Hygiene

- Hand Hygiene-a general term that applies to either handwashing, antiseptic handwash, antiseptic handrub, or surgical hand antisepsis
- Main Results: alcohol-based handrubs reduce bacterial counts on hands more effectively than plain soaps, and in a majority of studies more effectively than antimicrobial soaps.

Hand Hygiene and Nosocomial Infections

- Healthcare-associated infections (HAIs)-2 million cases per year (U.S.); 80,000 deaths per year
- \$5-10 billion per year (U.S.)
- Fraction of HAIs that are preventable with changes in hand hygiene practices not known
 - 38% due to cross-transmission
 - Increase in HW, reduction in HAIs

Hand Hygiene Practices in Healthcare

- Hand hygiene has been reported to average 40% (34 studies)
 - Inaccessibility of hand hygiene supplies
 - Skin irritation from hand hygiene agents
 - Inadequate time for hand hygiene
 - Interference with patient care
 - Lack of knowledge of the guidelines
 - Lack of information on the importance of hand hygiene

Hand Hygiene Practices in Healthcare

- Observational studies revealed that duration averages from 6.6 to 21 sec, and in 10/14 studies HW <15 sec, and in 8/14 studies HW \leq 10 sec
- HCWs also fail to wash all surfaces of their hands and fingers effectively

Hand Hygiene Study

Sickbert-Bennett et al. AJIC 2005;33:67-77

Studied efficacy of hand hygiene agents (n=14) following 10-second applications to reduce the level of challenge organisms from the hands of healthy volunteers using the ASTM-E-1174-94 test method

Hand Hygiene Agents

- Non-antimicrobial
- Antimicrobial
 - Chlorhexidine gluconate (CHG)
 - Triclosan
 - Quaternary Ammonium Compounds (QAC)
 - Parachlorometaxlenol (PCMX)
 - Alcohols (ethyl, isopropanol, n-propanol)
 - Iodine and Iodophors

Hand Hygiene Test Products

- Waterless hand rub products (5)
 - alcohol-based (60%-70%)
 - ◆ includes CHG or silver iodide
- Wipe products (2)
 - benzalkonium chloride (QAC)
 - PCMX with alcohol

Hand Hygiene Test Products

- Hand wash products (6)
 - CHG (0.75%, 2%, 4%)
 - Triclosan (1%)
 - benzethonium chloride (0.2%)
 - non-antimicrobial

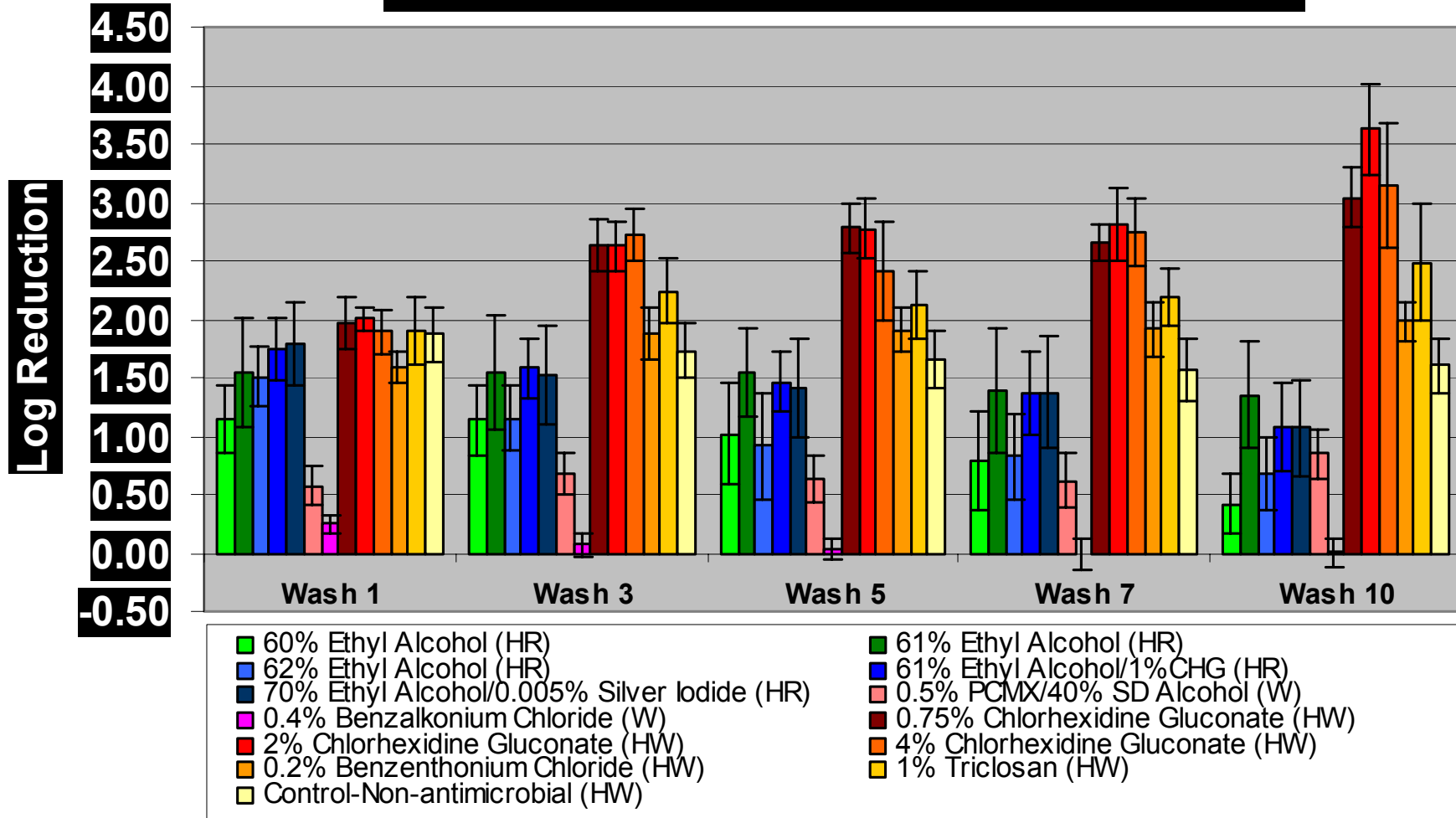
Hand Hygiene Test Products



Organisms

- ***Serratia marcescens***
 - Gram-negative bacilli
 - facultative anaerobe, non spore-forming
 - common opportunistic pathogen
 - found in soil, water, and on plants
- MS2 bacteriophage
 - 24-26 nm nucleocapsid with ssRNA
 - non-enveloped, hydrophilic, icosahedral
 - resembles human viruses of picornaviridae and caliciviridae family

Summary of Log Reductions of *Serratia marcescens*



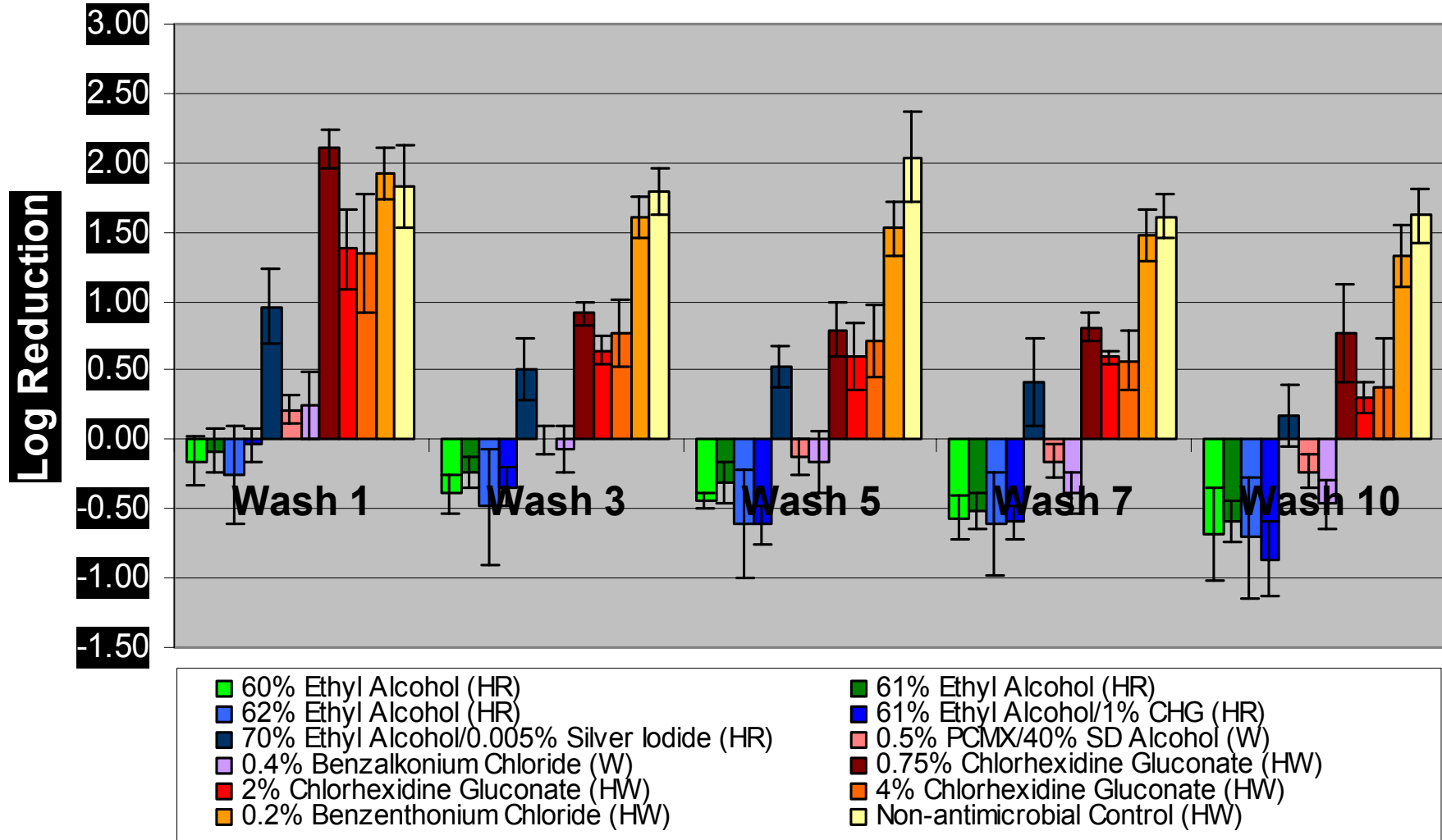
Hand Hygiene Study

- The decreasing efficacy of alcohol demonstrated after 10 episodes is most likely due to the lack of persistent antimicrobial effect of alcohols and the progressive accumulation of organisms on the hands following repeated episodes of contamination
- Use of alcohol-based handrubs an important addition to our efforts to improve hand hygiene compliance
- Likely that even a 90% reduction achieved by alcohol along with improved compliance will decrease HAIs

Summary of Results: GNR

- Wipes are not efficacious
- Waterless hand rubs useful for non-repeated washes
- Non-antimicrobial hand wash more efficacious than waterless hand rubs or wipes
- Antimicrobial hand washes with residual activity efficacious for repeated washes

Summary of Log Reductions of MS2 Bacteriophage



Summary of Results: Viruses

- Waterless alcohol-based hand rubs and wipes not efficacious
- Waterless alcohol-based hand rubs and wipes lead to an accumulation of organisms on the hands
- Antimicrobial hand washes have no benefit over non-antimicrobial hand wash

Conclusions

- Choose efficacious alcohol-based handrub to increase compliance
- Antimicrobial and nonantimicrobial handwash more effective than alcohol-based handrubs (UNC)
- Increased use of handrub, when combined with educational pgms, can lead to improved hand hygiene and reduce rates of HAIs
- Alcohol-based handrubs not effective in removing spores or viruses from hands

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- Pet Therapy
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- Washing machines
- Quats vs phenolics in pediatrics
- Pediatric Biological Response Plan

Thank you

References

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