### Definitions

<table>
<thead>
<tr>
<th><strong>Biocides</strong></th>
<th>Molecules that above certain critical concentrations &amp; under defined conditions will kill living cells within specific time.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Antiseptics</strong></td>
<td>Formulations that kill microorganisms and are safe for applications to the surface of living tissues.</td>
</tr>
<tr>
<td><strong>Disinfectants</strong></td>
<td>Formulations that kill microorganisms in the inanimate objects in a specified time.</td>
</tr>
</tbody>
</table>
Criteria for a good disinfectant

A wide range of microorganisms
Safe use
Rapid & long-last activity
Good compatibility
Ability to maintain efficacy
Lack of unwanted or toxic residues
Stability
Environmental friendliness
No resistance & cross resistance

An ideal disinfectant?
Disinfectants effectiveness depends on many factors.
Contact time

The death of microorganisms exposed to disinfectants takes place over a period of time.

Concentration

In general, the rate of microorganism inactivation increases when concentrations rises.
Factors affecting disinfectant activity

**Temperature**

In general, most biocides work at >68°F. The antimicrobial activity increases when the temperature rises.

**Organic matters**

Organic matters (e.g. milk, blood, pus, food residues, and faecal materials), heavy metal, cationic ions, and surfactants can hamper activity of disinfectants.
The antimicrobial activity of many disinfectants is quite markedly influenced by pH.

Factors affecting disinfectant activity

pH

Type/number/location of microorganisms

More resistant
- Prions
- Bacterial spores
- Mycobacteria
- Small, nonenveloped viruses
- Gm-negative bacteria
- Large, nonenveloped viruses
- Gm-positive bacteria
Less resistant
- Enveloped viruses
- Mycoplasma
Bacterial and viral envelope play an important role as disinfectant barriers.
Bacterial cell wall structure

**Gram positive**
- Teichoic acid
- Lipopolysaccharide
- Phospholipid
- Lipoprotein
- Peptidoglycan
- Phospholipid

**Gram negative**
- Lipopolysaccharide
- Phospholipid
- Lipoprotein
- Peptidoglycan
- Phospholipid
- OM
- PM
- IM

**Mycobacterium**
- Mycolic acid
- Arabinogalactan
- Peptidoglycan
- Phospholipid

**Mycoplasma**
- Sterol
- IM
Basic viral structure

Nonenveloped viruses
- Capsid (protein)
- Nucleocapsid
- Protein
- Nucleic acid
- Parvovirus, Papillomavirus, Poliovirus, Rhinovirus, Coxsachievirus, Piconavirus

Enveloped viruses
- Envelope (lipid/protein)
- Influenza virus, HIV virus
- Hepatitis B virus, Rabies virus, Vesicular stomatitis virus
How disinfectants enter the cells?

1. A biocide binds to cell surface.
2. This may cause alteration of outer membrane resulting in the penetration of the biocide.
3. The biocide reach the target sites within the cells.

Biocide-microorganism interactions
A variety of disinfectants are currently available.
Aldehydes

Glutaraldehyde

- Concentrations in formulation: 1.5-3.5% (generally 2%)
- A stable acidic forms activated at alkaline pH (7-8.5) before use
- Alkalinized solutions: potent biocides, shorter shelf life
- Board spectrum antimicrobial activity; bactericidal, virucidal, and sporicidal
- Stable, non-corrosive
- No deleterious effect on sensitive materials
- Good for temperature-sensitive medical devices
Glutaraldehyde

- Irritating & toxic to skin, mucous membrane & respiratory tract
- Absorbed by plastics and rubber
- Potential to fix materials onto a surface
- Mutagenicity???
- Resistance development

Glutaraldehyde-resistant
*M. chelonae* (also *M. avium*)

http://medicine.yale.edu/yjbm/att/mycobacterium-chelonae.aspx
http://legacy.revoptom.com/publish/images/2_13050_1.gif
Ortho-phthalaldehyde (OPA)

- Antimicrobial activity at 0.05-1% (wt/wt)
- A ready-to-use OPA formulation available at 0.55%
- Stable over a wide pH range (pH 3-9)
- No autopolymerization under alkaline conditions

- A rapid broad spectrum antimicrobial activity
- Less or no sporicidal activity
- Active against glutaraldehyde-resistant bacteria

- Odorless, less irritating & less noxious
- No need for activation

- Stain surfaces
- Adverse effects to skin, eyes, throat, lung
- Limited efficacy in the presence of soils

www.unimedmidwest.com/
Formaldehyde

- Used in an aqueous or gaseous form
- Typical concentration used 5-50 mg/l
- Formalin 34-40% (wt/wt) in water with 8-15% methanol

- A broad spectrum antimicrobial activity: bactericidal, mycobactericidal, virucidal
- Sporicidal activity?

- Cost effective and easy
- Compatible with a range of plastics & metals
Formaldehyde

- Less effective in the presence of soil & microorganism clumping
- Strong irritancy
- Toxic, mutagenic & carcinogenic
- Permanent damages to olfactory tissues
- Allergic reaction
- Corrosive to some materials
- Resistance in PAO & E. coli
Mode of action of glutaraldehydes

- Attack outer membrane protein
- Inhibit DNA/RNA synthesis
- Cross-link protein

Glutaraldehyde (-SH, -NH₂) attacks outer membrane protein, inhibiting DNA/RNA synthesis and cross-linking proteins. It interacts with amino acids such as Lys (Lysine) and Arg (Arginine).
Alcohols

- Isopropanol, ethanol, n-propanol
- Typical in-use concentrations: 50-90% (opt. 60-70%).
- Limited antimicrobial activity if >80%

- Broad spectrum activity with rapid bactericidal and mycobactericidal activity
- Variable activity against viruses
- Little or no activity against bacterial spores

- Little odor, nontoxic, inexpensive
- No residues, no environmental concerns
- Compatibility with surfaces

- Flammability risk
- Poor penetration

http://www.busytrade.com
Mode of action of Alcohols

- Disruption of amino-amino acid bonds
- Formation of amino-hydrogen bonds
- Protein denaturation, coagulation & precipitation
- Loss of structure & function

Cell lysis

Protein

DNA

Outside

Alcohol

Disruption of amino-acid bonds

Formation of amino-hydrogen bonds

Protein denaturation, coagulation & precipitation

Loss of structure & function
Biguanides

Chlorhexidine:
- A cationic-membrane active agent
- Salt forms: gluconate, diacetate, dihydrobromide
- More active at pH 5-7
- A rapid broad-spectrum bactericidal activity
- More active against Gram-positive bacteria
- No sporicidal activity
- Limited activity against viruses
- Used in combination with other biocides
Biguanides

**Alexidine:**
- Formulated in mouthwash & contact lens solution
- A rapid broad-spectrum bactericidal activity
- More rapid in action
- No sporicidal activity
- Higher skin irritancy

**Polymeric biguanides:**
- The heterodisperse mixtures of polyhexamethylenebiguanides (PHMB)
- Widely used for surface disinfection & water treatment
- Broad spectrum activity
- Not a potential efflux substrate
Biguanides

- Minimal irritation to skin, mucous membranes & wounds
- Substantivity on the skin and mucous membrane

- Eye irritants, hypersensitivity
- Environmental concerns
- Reduced activity in the presence of serum, blood & other organic matters
- Inactivated by nonionic surfactants and inorganic contaminants e.g., phosphate, chlorine
- Resistance development
Mode of action of chlorhexidine

A biphasic effect on membrane permeability

Outside

Disruption of cell wall & cell membrane

Leakage of cytoplasmic constituents

Ruptured area

CELL WALL

DNA/RNA

Amino acid

Chlorhexidine

Cytoplasmic constituents
Halogen & halogen-releasing agents

**Iodine (I₂)**

- Only two carrying antimicrobial activity; free iodine (I₂), & hypoiodous (HOI)
- Tinture of iodine, Lugol’s solution
- Iodophors: - increasing stability and solubility
  - N-vinyl-2-pyrrolidone
- Active at low pH

- Broad spectrum activity at low conc.
- 0.01- 1 mg of available iodine /l, 5 min for killing vegetative cells
- 10 mg/l, up to 5 h for sporicidal activity
Iodine ($I_2$)

- Iodophors: broad spectrum, little or no odor & non staining.
- Tolerate the presence of soils
- Little or no odor and taste, not irritating to eyes

- Surface staining
- Inactivated by QACs
- Irritating to broken wounds and mucous membrane
- Corrosive to metals and some plastics
- Thyroid function???
- Great resistance in nonenveloped viruses
The presence of active chlorine compounds, formed in water i.e., Cl₂, hypochlorous acid (HOCl), hypochlorite acid (OCl⁻).

Cl₂ + H₂O ⇌ H⁺ + HOCl + Cl⁻
HOCl ⇌ OCl⁻ + H₃O⁺
OCl⁻ ⇌ Cl⁻ + O

↓ pH, ↑ HOCl, ↑ antimicrobial efficacy
↑ pH, ↑ OCl⁻, ↓ antimicrobial efficacy
Optimal pH 4-7
Chlorine ($\text{Cl}_2$)

- **HOCI**
  - Only found in solution
  - Most active of all chlorine form
  - 80-100% more effective than OCl$^-$
  - Kill bacteria & viruses within 2 sec

- **OCl$^-$**
  - A weaker form of free chlorine
  - Serve as a bank of less active chlorine
Chlorine (Cl₂)

- Reliable broad spectrum antimicrobial activity
- Remove biofilms
- Active against both enveloped and nonenveloped viruses

- Colorless, cost-effective, easy to handle, nontoxic
- Remain activity at high water hardness level

- Corrosive
- Irritants and hypersensitivity at higher conc.
- Produce chloramine resulting in stronger odor
- Toxic to fish and other aquatic species
- Produce by product “THM” a potential carcinogen
Sodium hypochlorite (NaOCl)

- Salt of HOCl in powder or liquid preparation
- Typical liquid form containing 1-15% available chlorine

\[
\text{Cl}_2 + 2\text{NaOH} \rightarrow \text{NaOCl} + \text{NaCl} + \text{H}_2\text{O}
\]

\[
\text{NaOCl} + \text{H}_2\text{O} \leftrightarrow \text{HOCl} + \text{NaOH} \leftrightarrow \text{Na}^+ + \text{OH}^- + \text{H}^+ + \text{OCl}^-
\]

\[
\text{HOCl} + \text{H}_2\text{O} \leftrightarrow \text{HCl} + \text{O}
\]

- Need a large scale to get the comparable killing activity
Chloramine

- Liquid or powder form
- Inorganic chloramine e.g., \( \text{NH}_4\text{Cl}, \text{NHCl}_2 \)
- Organic chloramine e.g., Chloramine T, sodium dichloroisocyanurate

- Less irritant & more stable
- Greater activity under acidic conditions & in the presence of soil
- Oxidized some unwanted & harmful organic & inorganic compounds

- Less antimicrobial activity than hypochlorite
Sodium dichloroisocyanurate (SDIC)

- Obtained from the reaction of HOCl & amine or imine
- Provided in either anhydrous or dehydrate forms
- Slowly releases chlorine and some other compounds, e.g. chlorinated isocyanurates, non-chlorinated isocyanurates & HOCl

- An alternative chlorine-releasing agent to hypochlorite
- Accumulation of cyanuric acid
Mode of action of chlorine

- Impair enzyme & protein function
- Leakage of intracellular constituents
- Alter cell permeability
- Interfere cell membrane associated function

Aldehydes, CO, NH₃, nitrile

Chloramine

Nucleic acid denaturation
Peroxygens & other oxygen-releasing agents

**H₂O₂**

- Commonly available as the 3-90% colorless solutions
- Typical conc. for industrial use are 35-50%.

- Active against bacteria, mycobacterium, spores & viruses
- More effective against Gram-positive than Gram-negative bacteria

- Safe for skin & applicable to many materials
- Environmental friendly

- Needs to be stored in tightly-closed light-proof bottles
- Can be toxic, corrosive and carcinogenic
- A potential mutagen
- Resistance development
Peracetic acid (PAA)

- Commercially available at 5-37% liquid
- Usually combined with $\text{H}_2\text{O}_2$ and acetic acid & a stabilizer

- Sporicidal, bactericidal, tuberculocidal at low conc. (<0.35%)
- Variable virucidal activity

- A great activity in the presence of organic soils.
- Decomposes into safe and nontoxic by-products

- Corrosive, pungent odor, irritating
- React with plastics, copper and aluminiums
- Lose its stability easily during storage
- Needs to be stored in strong-invented container

http://www.evansvanodine.co.uk/Images/Agri/Livestock_Protection/Vanodox.jpg
Chlorine dioxide

- A reactive free radical existing as a water soluble gas
- Spectrum of activity similar to chlorine
  - Active over a wide pH range (pH 6-10)
  - Biofilm control
- No odor & color at typical conc.
  - Neutralize some harmful chemicals
  - Chlorine dioxide gas provides better & faster fumigation.
- Very short half life & high-light sensitivity
  - Very irritating at high conc.
  - Corrosive to some metals
Potassium peroxymonosulfate, KHSO$_5$

- Triple salts $2\text{KHSO}_5\cdot\text{KHSO}_4\cdot\text{K}_2\text{SO}_4$ activity against bacteria, virus and fungi.
- Used in synergistic combination with chlorine-releasing agents, particularly SDIC

- Rapid antimicrobial activity against bacteria & virus

- Heat-tolerant, non-corrosive and non-irritating
- Not stain surfaces
- Odorless, colorless, highly stable at room temperature

- Can cause acute toxicity and be severely toxic to eyes
- Toxic to birds??
Disruptions of peptide bonds

Oxidation of proteins, fatty acids and nucleic acids

Dissociation & conversion of 70S ribosomes to ribosomal units

Mode of action of oxidizing agents

- DNA/RNA
- 70s ribosome
- Protein

OH

OH

OH

OH

OH

OH

OH free hydroxyl radicals
Copper (Cu$^{2+}$)

- Essential element
- Available in variety of form
- Most common used form is CuSO$_4$.5H$_2$O.
- Less active at pH>8
- Cu$^{2+}$ is the actual biocide.

- Bactericidal particularly at low conc.
- Effective against both enveloped & nonenveloped viruses
- No sporicidal or sporistatic activity
Copper ($\text{Cu}^{2+}$)

- Powerful & stable even at low conc.
- Cost effective, easy to use, colorless & odorless
- “Copper-silver ionization”
  alternatives to chlorine water treatment

- Toxic and skin irritancy at high conc.
- Bioaccumulation, particularly aquatic environment
- React with other chemicals producing unwanted deposits on surfaces
- Resistance development
Silver ($\text{Ag}^{2+}$)

- Widely used biocide silver: $\text{AgNO}_3$, AgSD
- $\text{Ag}^{2+}$ is the active species.

- Active against bacteria, particularly Gram-positive bacteria
- Effective bactericidal activity at low conc.
- Little virucidal activity

- Not irritating to skin or mucous membrane
- Residue antibacterial activity
- Less aggressive on surfaces

- Skin and mucous membrane burn at high conc.
- Resistance development
- Reduced efficacy by contaminants
Mode of action of copper

- Copper-mediated catalysis
- Produce hydroxyl radicals
- Damage protein, lipid, nucleic acid

1. Rapidly attach to cell surfaces
2. Disrupt 2nd & 3rd structures of proteins
3. Alter cell permeability, disrupt cell wall, protein denaturation & precipitation

- Bind to phosphate backbone of DNA
- DNA degradation

- DNA
- Protein

CELL WALL
Mode of action of silver & silver sulfadiazine

- **Ag$^{2+}$**: Rapidly attach to cell surfaces, disrupt cell wall, bind to $-\text{SH}$, amino & carboxyl groups leading to protein denaturation.

- **AgSD**: Produce membrane & surface blebs, bind to DNA helix, inhibit transcription & replication.

**CELL WALL**

- **Protein**: Contains $\text{NH}_2$, $\text{SH}$, $\text{SH}$, $\text{COOH}$ groups.

- **DNA**
# Phenolics

Various types of phenolic compounds

<table>
<thead>
<tr>
<th>Category</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal tar</td>
<td>phenol, cresol, xylenol</td>
</tr>
<tr>
<td>Non-coal tar</td>
<td>2-phenylphenol, 4 hexylresorcinol</td>
</tr>
<tr>
<td>Halogenated phenols</td>
<td>chloroxylenol, 4-nitrophenol, 2-chlorophenol, chlorocresol</td>
</tr>
<tr>
<td>Bisphenols</td>
<td>triclosan, hexachlorophene, fenichlor</td>
</tr>
<tr>
<td>Others</td>
<td>salicylic acid, 8-hydroxyquinoline, 2,3-diaminophenol</td>
</tr>
</tbody>
</table>
Phenolics

- Insoluble in water
- Combine w/ soap, oils & anionic detergent
- Formulation effects play a key role in the optimization of phenol activity.
- The more lipophilic the phenolic, the more activity against enveloped viruses.

- Broad spectrum intermediate-level disinfectants
- Rapid activity against Gram-positive, Gram-negative bacteria, Mycobacteria and viruses
- Sporistatic but not sporicidal
 Phenolics

- Tolerate the presence of organic & inorganic soils
- Formulated for both cleaning & disinfection
- Some residue activity
- Stable in storage

- Skin/eye irritants, relatively toxic
- Strong odor
- Restricted use in nurseries
- Corrosive to some plastic & rubber surfaces
- Resistance development
The -OH group is very reactive.

- Form H-bond with macromolecules, particularly protein.
- Damage cell wall & membrane.
- Inactivate essential membrane function.
- Leakage of intracellular constituents.

Mode of action of phenolics:

**Phenolics**

**DNA/RNA**

**Protein**

**Cell wall**
QACs

- Surface-active agents (Surfactants)
- QACs, the most widely used cationic surfactant
- BKC, cetrimide (CTAB), cetylpyridinium chloride (CPC)

- Vary in antimicrobial activity α type & formulation
- No sporicidal activity
- Bacteristatic, tuberculostatic, sporistatic at low conc. (< 500 μg/ml)
- Gram positive bacteria are very sensitive (<10 μg/ml).
- Effective against enveloped viruses
QACs

- No requirement of rinsing off following application
- Noncorrosive, nonstaining, pleasant odor
- Retain efficacy in organic materials
- Nontoxic, no skin irritation at conc. used
- Stable in storage

- Reduced activity in hard water, fatty materials, anionic surfactants
- Difficult to rinse off
- Excessive foaming
- At higher conc., irritating to skin and mucous membrane
- Resistance development
Mode of action of QACs

- Rapid absorption & penetration of cell wall
- Disruption of structure & function of cell wall
- Disruption of membrane lipid, enzyme, protein
- Leakage of cytoplasmic constituents

QACs

Protein

Cytoplasmic constituents
Summary of target sites & effects of disinfectants

Cell wall/OM

- Chlorhexidine
- QACs
- Glutaraldehyde
- Chlorine
- High conc. Chlorhexidine
- QACs, Phenols
- Hexchlorophene

IM

- Leakage
- DNA
- Amino acids
- Electron transport
- ATPase
- Coagulation
- -SH
- -NH₂
- PMF
- Lysis
- Glutaraldehyde
- Formaldehyde
- Chlorine
- Iodine
- H₂O₂, Ag²⁺

Organic acids
- Hexchlorophene

Chlorhexidine
- QACs, Phenols
- Alcohols
- Hexchlorophene

Chlorhexidine

Hexchlorophene
Inactivation of viruses

**Enveloped viruses**
- Envelope (lipid + protein)

**Nonenveloped viruses**
- Capsid (protein)

“Complete viral inactivation must include destruction or damages of nucleic acids.”
Chlorine inactivation of viruses

Penetration of lipid envelope & proteinaceous capsid (conformation shift)

Disruption of peptide bonds
Substitution of benzene rings on Tyr
Deamination of ammonia
Change of viral antigenic properties

Disruption of viral genome
Combination of biocides

Possible responses

- Antagonistic
- Additive
- Synergistic

Examples:
- Chlorhexidine, Alcohol, QACs
- Phenolics, alcohol
- QACs, surfactants, propan-2-ol
Bacteria and virus can develop resistance to disinfectants.
Which disinfectants potentially promote resistance?

Nonresidue producers:
- Alcohols
- Aldehyde
- Oxidizing agents
- Chlorine
- Iodine

Residue producers:
- Biguanides
- Phenols and cresols
- Heavy metals
- QACs
Example of resistance mechanisms to disinfectants

Gram-negative bacterial cell envelope & the *Mycobacterium*-complex cell wall provides an effective barrier to the entry of disinfectants.

Gram-negative bacterial cell envelope

Mycobacterial cell wall structure

- Outer membrane
- Periplasm
- Inner membrane
- Cytoplasm

- Lipoarabinomannan
- Mycolic acid
- Arabinogalactan
- Peptidoglycan
- Cell membrane
Slime/biofilm production reduced permeability to disinfectants.

Example of resistance mechanisms to disinfectants

*P. aeruginosa* biofilm

Mucoid strains of *S. aureus*
Active efflux pumps out low concentration of disinfectants, resulting in reduction of the intracellular concentration of disinfectants.

The QacA system in *S. aureus*

Substrates: QACs, chlorhexidine, salts, acridine, ethidium bromide
Resistance to disinfectants in viruses

1. Indirect factor
   - Virus clumping
   - Protective factors e.g., cell debris, soil, organic salts, lipids, carbohydrate etc.

2. Direct factor
   - The structure of virus particle e.g. the presence of envelope, lack of damage to nucleic acid
How can virus acquire resistance?

Poliovirus

Gradual passage through increased conc. of chlorine

Virus adaptation

Secondary or tertiary changes of structural capsid

Increased tolerance of chlorine inactivation in poliovirus
Development of cross-resistance between disinfectants and antibiotics

1. Microorganisms expose to a disinfectant at sub-lethal level.
2. Microorganisms develop resistance to the disinfectant.
3. Microorganisms develop resistance to multiple antibiotics simultaneously.
Active efflux is a common mechanism for biocide and antibiotic resistance.

The AcrAB-TolC efflux systems in *Salmonella enterica*
## Biocide adaptation/mutation and cross-resistance

<table>
<thead>
<tr>
<th>Species</th>
<th>Adapted to</th>
<th>Cross-resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRSA</td>
<td>BKC</td>
<td>Ofloxacin, oxacillin, cloxacillin</td>
</tr>
<tr>
<td><em>S. aureus</em></td>
<td>QACs, Chlorhexidine</td>
<td>norfloxacin, ofloxacin</td>
</tr>
<tr>
<td><em>E. coli</em></td>
<td>Chloroxylenol, chlorhexidine, QACs, glutaraldehyde, iodine</td>
<td>Tetracycline, ampicillin, streptomycin, chloramphenicol</td>
</tr>
<tr>
<td><em>E. coli</em></td>
<td>BKC</td>
<td>Ampicillin, penicillin, nalidixic acid, kanamycin, gentamycin, erythromycin</td>
</tr>
<tr>
<td>S. Virchow</td>
<td>Chlorhexidine, BKC</td>
<td>Amikacin, amoxillin, imipenem, chloramphenicol, trimethroprim</td>
</tr>
<tr>
<td><em>Salmonella</em></td>
<td>Phenolics</td>
<td>ampicillin, ciprofloxacin</td>
</tr>
<tr>
<td><em>E. coli</em></td>
<td>Formaldehyde</td>
<td>Glutaraldehyde</td>
</tr>
</tbody>
</table>
How important in clinical settings?

Susceptibility of *Salmonella enterica* to selected biocides (*n*=180)

<table>
<thead>
<tr>
<th>Agent</th>
<th>Sources</th>
<th>% of isolates with MICs (µg/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>BKC</td>
<td>Poultry</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Swine</td>
<td></td>
</tr>
<tr>
<td>CHK</td>
<td>Poultry</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Swine</td>
<td></td>
</tr>
<tr>
<td>ZnCl₂</td>
<td>Poultry</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Swine</td>
<td></td>
</tr>
<tr>
<td>CuSO₄</td>
<td>Poultry</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Swine</td>
<td></td>
</tr>
</tbody>
</table>

No or only a limited degree of developed resistance to the disinfectants

Chuanchuen et al, 2008 JVMS, 595-601
**How important in clinical settings?**

*In vitro* exposure to BKC promote cross-resistance to antibiotics

<table>
<thead>
<tr>
<th>Strains</th>
<th>MIC (µg/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CHP</td>
</tr>
<tr>
<td>SA030 (pre-exposed)</td>
<td>2</td>
</tr>
<tr>
<td>SA030 (post-exposed)</td>
<td>64</td>
</tr>
</tbody>
</table>

Chuanchuen *et al.* unpublished data
Boot bath, a protector or provider of pathogens?
Are bootbaths really efficient?

A sense of responsibility
Awareness of biosecurity

Personnel avoid stepping into boot bath.
No removal of visible manure
Insufficient contact time
Poor boot bath maintenance
Stepping through or standing without removing organic material first did not disinfect boots.

Scrubbing manure off in a water bath is as effective as that in a disinfectants bath for reducing bacterial counts.

Soak boots scrubbed free of manure for 5 min or more to meet the standard for disinfection.

Type of disinfectants is irrelevant if manure is not removed.
Which disinfectants are good for boot baths?

- Broad spectrum
- Fast working
- Retaining a long residual action

- Most commonly used: Phenolics
- Chlorhexidine
- Per-oxy compounds
- Didecyldimethylammonium chloride
- A combination of aldehydes & QACs or peracetic acid & hydrogen peroxide

http://www.fwi.co.uk.academy.article:116013:salmonella-in-layers-2-control.html
New development of disinfectants

- A combination of FeCl₃.H₂O, cysteine, ascorbic acid, potassium, SDS
- Potassium fluoride peroxohydrate
- Superoxidized Water
- Peracetic acid and 5,7-diphenyl-1,3-diazoadamantan-6-one
- Poly-[2-(2-ethoxy)-ethoxyethyl]-guanidininium-chloride]
- A mixture of polymeric biquanides (poly-(hexamethylene-guanidininium-chloride & poly-[2-(2-ethoxy)-ethoxyethyl]-guanidininium-chloride])
- Novel formaldehyde-releasing agents e.g., taurolin, hexamine
The Chuanchuen lab

Thank you
Across 1. Hypochlorous
2. Resistance
3. Peroacetic acid
4. A disinfectant obtained the reaction between hydrogen peroxide and acetic acid
5. A chlorine-releasing chlorine agent
6. When combine two disinfectants, the combined activity is greater than that of sum of individual ones.
7. A mechanism that mediates cross resistance between disinfectants and antibiotics
8. A cationic surfactant that is commonly used for disinfection
9. A potentially carcinogenic agent produced by chlorine

Down 9. A potentially carcinogenic agent produced by chlorine