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Special points of interest:

- **Biofilms**
- **Segregating Waste into Stericycle's Pharmaceutical Waste Bins Properly**

Inside this issue:

Hospital Waste

Biofilms: Progress in Defeating HAIs

Biofilms have been the enemy of patient caregivers, central processing, environmental services and facilities staff in healthcare facilities for hundreds of years. Biofilms are factors in 65% of all hospital-acquired infections (HAIs). They defeat antibiotics, form inside medical instruments, and they coat water pipes, drinking fountain and ice machine supply lines.

So what are biofilms? Bacterial colonies create biofilms by secreting polysaccharides, DNA and proteins to form a three dimensional matrix. Importantly, biofilms exhibit a markedly decreased vulnerability to antimicrobial agents. Further, because biofilms are comprised primarily of water, they contain channels which bring nutrients to the attached cells within the matrix.

Biofilms readily form on a wide variety of indwelling medical devices including:

Central venous catheter—Coagulase-negative staphylococci, *Staphylococcus aureas, Enterococcus faecalies, Klebsiella pneumoniae, Pseudomonas aeruginosa, Candida ablicans*

Prosthetic heart valve—Viridans *Streptococcus*, coagulase-negative staphylococci, enterococci, *Staphylococcus aureaus*

Urinary catheter—*Staphylococcus epidermidis, Escherichia coli, Klebsiella pneumoniae, Enterococcus faecalis, Proteus mirabilis*

Artificial hip prosthesis—Coagulase-negative staphylococci, β-hemolytic streptococci, enterococci, *Proteus mirabilis, Bacterioides* species, *Staphylococcus aureaus*, viridans *Streptococcus, Escherichia coli, Pseudomonas aeruginosa*

A: Biofilm. B: Substrate. C: Attached bacteria. [From the American Society for Microbiology MicrobeLibrary and used with permission of the authors: R. M. Donlan & D. Gibbon]

Artificial voice prosthesis—*Candida albicans*, *Streptococcus mitis*, *Streptococcus salivarius, Rothia dentrocariosa*, *Candida tropicalis, Streptococcus sobrinus, Staphylococcus epidermidis, Stomatococcus mucilaginous*

Intrauterine device—*Staphylococcus epidermidis*, *Corynebacterium* species, *Staphylococcus aureus*, *Micrococcus* species, *Lactobacillus plantarum*, group B streptococcis, *Enterococcus* species, *Candida albincans*[1]

Biofilms readily form on smooth surfaces including Teflon, plastics, latex, silicone, glass and various metals. This has stimulated research into surfaces that

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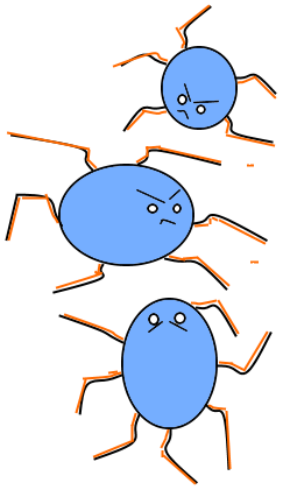

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may repel or inhibit the adhesion of bacterial colonies. By making surfaces rough on a nanometer scale biofilms may form much more slowly. Copper, silver and antibiotic-impregnated materials also deter biofilms.

Other research strategies into biofilms include:

1. Weakening the structural matrix using enzymes that break apart DNA molecules;
2. Ferrying antimicrobial agents into the interior of biofilms using liposomes, which meld with bacteria cell walls and release their cargo; and
3. Using a signal fatty acid to tell bacteria to leave the biofilm matrix.

Generally, rough or hydrophobic surfaces will colonize bacteria more quickly than smooth ones. However, any material placed into a fluid environment will quickly develop a conditioning film composed of proteins that are always present. Conditioning films will completely alter the nature of the surface.

After attachment to a conditioning film bacteria will begin dividing, forming colonies and producing extracellular polymers for the biofilm matrix.

Biofilms can function as filters and traps to capture nutrients, minerals and other materials. Antibiotics are also trapped by these matri-

Rapicide-PA, Acecide-C, and Other Peroxyacetic Acid-based Disinfectant Waste May Violate Local Wastewater Discharge pH Standards

Does your facility conduct invasive patient procedures that require scopes or probes to be disinfected between patients? Most healthcare facilities are no longer using glutaraldehyde or even o-phthalaldehyde (OPA) - based disinfectants and have adopted either heated hydrogen peroxide (e.g. Trophon EPR) or peroxyacetic acid-based cold, high-level disinfectants (Olympus and Medivator). Acecide-C™ and Rapicide-PA™ are two common peroxyacetic acid-based cold, high-level sterilants.

While hydrogen peroxide yields only water and oxygen as waste products, the spent peroxyacetic acid waste is still acidic, usually having a pH ≈ 4.5. While this does not cause the waste to designate as hazardous, it may still be too acidic to be safely discharged untreated to the sanitary sewer.

Resert™ XL HLD, which uses 2-furoic acid, has a similar issue with pH.

Most scope reprocessors are plumbed directly to a sink or floor drain. It is the legal responsibility of the waste generator to designate his/her waste.[1]

Most scope reprocessor wastes should not be reported on a facility's Dangerous Waste Annual Report as they do not designate as corrosive waste (D002), although there are exceptions.[2]

Several municipalities in western Washington require that wastewater have a minimum pH of either 5.0 or 5.5 before they can be discharged to the sewer. These include King County and the City of Everett.

Waste from a reprocessor can often be treated with a mild base such as sodium bicarbonate or sodium carbonate solution to raise the pH slightly. Some manufacturers are aware of these wastewater restrictions and provide technical bulletins to customers to aid them in complying with local discharge regulations.

If your facility does use one of these disinfectants and you decide to treat the waste before discharge, you do not have to log the neutralization process or report it on your facility Dangerous Waste Annual Report. It would not fall under Ecology's Treatment by Generator regulations.

[1] WAC 173-303-070-100 170 (1)

[2] Steris 1E Liquid Chemical Sterilant Processing System waste may designate as federal hazardous waste, D002.

(Continued from page 2)

ces, often before they can interact with the bacteria.

Recent research has shown that bacteria secrete different proteins at different stages of biofilm construction, resulting in more and more complex matrices. The matrix itself, composed of long strands of polysaccharides, DNA and proteins, protect the bacteria by blocking antibiotics and gluing the colony together and to the surface.

Although enzymes can be effective in degrading the polymer matrix, each biofilm has a different composition and may require different enzymes.

Phages (viruses) can infect and destroy biofilm colonies. Like enzymes, however, they must be very specific for the bacteria. Phages can also be packaged into liposomes composed of lipids similar to bacterial cell walls. The liposomes fuse with bacteria and disgorge their phage cargo directly into the bacteria.

In the end, multiple strategies will probably be required to defeat slime and reduce the incidence of hospital-acquired infections.

[1]"Biofilm Formation: A Clinically Relevant Microbiological Process." Clin Infect Dis. 2001;33(8):1387-1392. doi:10.1086/322972. Clin Infect Dis | © 2001 by the Infectious Diseases Society of America. Used with permission.

Reference: Karin Sauer. "The War on Slime" Scientific American, November 2017, pp. 65-69.

Segregating Pharmaceutical Waste Among Stericycle's Biosystem Black Containers

Many healthcare facilities have adopted Stericycle's Biosystem of co-mingling sharps and non-hazardous pharmaceutical waste. This system, which is compliant with Ecology's 2016 *Interim Pharmaceutical Waste Policy*, allows non-hazardous pharmaceutical waste to be incinerated more cheaply at a medical waste incinerator. It also conforms to the decades-old habit of many caregivers of tossing unwanted pharmaceuticals into the same container as sharps.

However, hazardous pharmaceutical waste must be segregated into other containers for shipment and incineration at a RCRA-permitted facility. These smaller, black plastic waste containers are labeled:

- Flammable / Toxic (D001 and others)
- Corrosive (D002)
- Reactive (D003)
- Oxidizer (D002, D003)

Below is a guide as to what pharmaceutical waste can be placed into each:

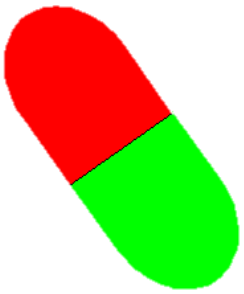
CORROSIVE: glycopyrrolate

OXIDIZER: silver nitrate

REACTIVE: Albuterol, Atrovent, Cetacaine, Flovent and Ventolin

FLAMMABLE / TOXIC: Apidra, Aquadeks, Ayr Saline Gel, Bactroban, Benzoin, Byetta, Chlorhexidine gluconate, Clobetasol propionate, Cortifoam, Cortisporin-TC, Coumadin, Cyclophosphamide, Cyclosporine (soln), Dermoplast, Digoxin, Diazepam (inj), Docetaxel (inj), Donnatal (elixir), Flurbiprofen (soln), Gel-Stat, Humalog, Humira pen, Humulin (inj), Hurricaine, Ixempra (inj), Lanoxin (inj), Lantus (inj), Lindane, Loperamide (soln), Lupron Depot, Malathion lotion, Mitomycin, Neo-Synephrine, Neomycin/Polymixin/Hydrocortisone, Nicotine, Nitrolingual spray, Paclitaxel (inj), Peppermint spirits, Phenobarbital (elixir or inj), Phenytoin (inj), QVAR (aerosol), Sandimmune (soln), Selenium sulfide, Silvadene, Silver sulfadiazine, Toposar (inj), Torisel, Transderm-Scopalamine, Trifluridine, and Trisenox (inj).

All other pharmaceutical waste—except chemo drug waste—can be considered non-hazardous and put into the blue bins co-mingled with sharps. Please see the article on page 4 for chemo waste guidance.



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Segregating & Managing Chemotherapy Drug Waste

Chemotherapy drug waste can be managed as one waste stream or as two. The advantage to two stream management is that the bulk of your chemo drug waste can be incinerated more cheaply as non-hazardous.

If your facility doesn't generate much chemo drug waste, it's probably easier and simpler to treat both bulk chemo drug (when drug is visible to the eye) and trace chemo drug (when there's no visible evidence) as one waste stream. This management method will require incinerating all of your chemo drug waste at a RCRA Part B-permitted facility.

If your facility generates a fair amount of chemo drug waste, consider segregating bulk from trace chemo waste. Bulk (visible drug in a vial, IV bag, tubing or syringe) should be managed as hazardous waste and incinerated at a RCRA Part B-permitted facility.

Trace chemo waste—which includes nearly all PPE used by caregivers (gowns, gloves, masks, face shields) that has no visible contamination as well as empty vials and vial boxes can be incinerated more cheaply at a municipal or medical waste facility as non-hazardous pharmaceutical waste.

To fully comply with Ecology's *Interim Pharmaceutical Waste Policy* your facility should file a Pharmaceutical Waste Profile with Ecology.