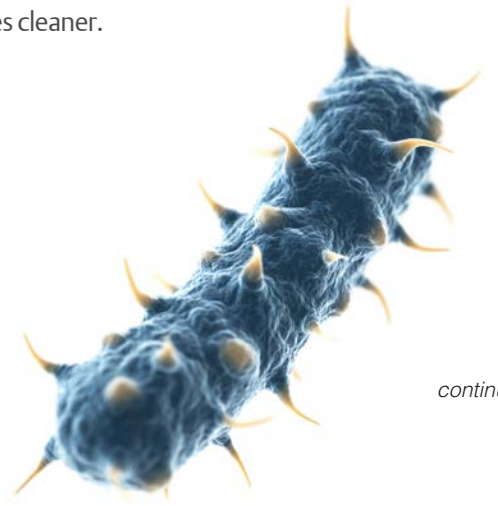
EMBEDDED ANTIMICROBIALS IN HEALTHCARE STORAGE & TRANSPORT EQUIPMENT

Healthcare associated infections (HAIs) are a major source of morbidity and mortality throughout the U.S.[1]

The results of a prevalence survey conducted to describe the impact of the burden of HAIs in acute care hospitals nationwide reported that, for 2011, 721,800 HAIs occurred in acute care hospitals and approximately 75,000 patients with HAIs died during the course of their hospitalizations.[2,3] Healthcare–associated infections are also linked to significant economic consequences for the healthcare system; the overall direct costs of HAI to U.S. hospitals range from $35.7 billion to $45 billion annually for inpatient hospital services.[4]

In addition, the Centers for Disease Control and Prevention (CDC) estimates that 80% of all infections are caused by touch.[5]

For these reasons, many in the healthcare industry are seeking alternative sanitation practices to maintain cleaner surfaces for longer periods and minimize the survival of microbes. Integration of antimicrobial protection into equipment and supplies is an option, as part of a systems approach to keeping surfaces cleaner.



continued >>>

THREE TYPES OF MICROORGANISMS IMPORTANT IN HEALTHCARE [6]

The three types of microorganisms involved in surface contamination include bacteria, fungi (mold, mildew, and yeasts) and algae.

FIGURE 1 BACTERIA

1/ Bacteria (see Figure 1) are simple, fast-growing unicellular organisms with no true nucleus, surrounded by a cell wall that can be classified as Gram-negative or Gram-positive.[7,8]

Gram-negative bacteria *are spread worldwide, in virtually all environments that support life. The commonly known Gram-negative bacteria include:*

> Escherichia coli (E. coli)

> Klebsiella pneumoniae (causes ventilator associated pneumonia[9])

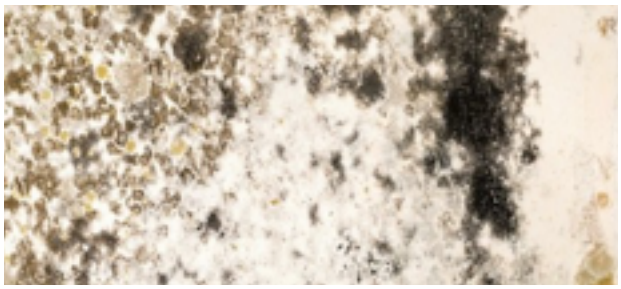
> Pseudomonas aeruginosa; and Salmonella

Gram-positive bacteria *are bacteria that give a positive result in the Gram stain test. Commonly known Gram-positive bacteria include:*

> Staphylococcus aureus (MRSA)

> Streptococcus pneumoniae (strep throat); and Listeria

FIGURE 2 FUNGUS



2/ Fungus Spores (see Figure 2) were first discovered in 1588, around the time the microscope was invented.[10] (see Figure 2). Fungi can be generally characterized as single-celled (yeasts) or multi-celled (mold, mushrooms, etc.).

3/ Mildew & Mold are both fungi and essentially refer to the same organisms, with mildew being a more colloquial name for mold.[11,12] Commonly known molds are:

Aspergillus *(Aspergillus is a fairly allergenic mold that is commonly found on foods and in home air conditioning systems);*

Cladosporium *(black or green "pepper like" substance that grows on the back of toilets, painted surfaces and fiberglass air ducts);*

Stachybotrys atra *(also known as black mold causing sick building syndrome);*

Penicillium *(common mold that produces penicillin).*

continued >>>

ANTIMICROBIALS

Antimicrobials are substances that inhibit the growth of microorganisms. They can be synthetic or natural. Various antimicrobial substances have been used to rid the body of infections for many years. This broad range of compounds can also be utilized to prevent microbial degradation of products by including antimicrobial protection treatments as part of the product manufacturing process.

Types of Antimicrobials

The types of antimicrobials that are used in healthcare today include antibiotics, disinfectants and industrial antimicrobials.

Antibiotics *refer to substances produced by microorganisms or synthesized in a lab that act against another microorganism. Antibiotics are specialized antimicrobials utilized for treating patients with microbial infections.*

Disinfectants *are chemical liquids that destroy vegetative or spore forms of harmful microorganisms such bacteria and fungi. Specific disinfectants must be utilized to target spores.*

Industrial antimicrobials *are broad spectrum antimicrobials utilized for product preservation, odor control and the control of stain causing microorganisms. These are often what is employed when incorporating an antimicrobial into a material. These antimicrobials generally have multiple modes of action against microbes.*

Industrial Antimicrobials Currently in Use

Certain early antimicrobial products have been replaced with more evolved antimicrobial solutions that are tested regularly to meet high standards of efficacy and safety. Common industrial antimicrobials in use today include:

Silver *has long history of use, dating back to 400 BC. When used as an antimicrobial agent, small amounts of silver disrupt the bacteria's metabolism, thereby preventing it from converting nutrients into energy, which inhibits bacteria survival, reproduction and colonization.*

Zinc pyrithione *is commonly and effectively used in dandruff shampoo, antiseptics, sponges, footwear, and fitness mats; it is a colorless solid effective at low concentrations. Zinc antimicrobials decrease cellular energy and alter the cell membrane.*

Quaternary silane *is a quaternary ammonium salt that consists of a positively charged amine group which can disrupt cell membranes. Quaternary silane antimicrobials alter the cell membrane, causing the cell to burst. Quaternary silane binds to surfaces for enhanced durability; it is used as an antimicrobial primarily in textile products.*

Polyhexamethylene biguanide (PHMB) *is a fast-acting and widely used polymer that is highly effective against a broad set of bacteria. PHMB negatively impacts DNA replication so that new cells cannot be made. PHMB is used as an antimicrobial primarily in textile products.*

Antifungals. *There is a diverse variety of fungi that will cause issues in building applications, whether causing simple aesthetic issues or truly material-damaging degradation. Organic and metallo-organic antifungal additives are available to control fungi in construction materials.*

ANTIMICROBIAL TECHNOLOGY

The best defense against the growth of bacteria, mold, and mildew is prevention. Healthcare products and equipment utilizing antimicrobial product protection are resistant to the growth of bacteria, mold and mildew. Utilizing antimicrobial products is important, as healthcare products and equipment can easily be contaminated with ideal nutrient sources for these microorganisms. Built-in product protection inhibits microbial reproduction and offers protection throughout the product's useful lifespan. Specifically, healthcare storage products, such as carts, shelving, etc., can be susceptible to contamination, especially if they are mobile and wheeled into different areas of the facility.

continued >>>

Why do Products Need Antimicrobials?

The main purpose of an antimicrobial treatment is to address the problems of degradation, staining, and odor on products by helping to control microbial growth on surfaces.

> ***Degradation.*** *Microbes can cause degradation and breakdown of the product. For example, ceiling tiles support the growth of mold and fungi by providing a food source. As the fungi eat the material, the structural integrity is damaged.*
>
> ***Staining.*** *Some bacteria, mold and algae have pigmented cells. As the microbes grow, they cause a discoloration or staining of the product.*
>
> ***Odor.*** *As microbes grow, waste can result in an odor on the product. This is the root cause of lingering body odor in textiles.*

Within the healthcare environment microbes can be present on handrails, door handles, curtains, shelving, mobile carts, bed linens, toilets and other medical devices. One study demonstrated that cleaning bed rail surfaces with hospital-approved disinfectants decreased the intrinsic bacterial burden on these surfaces by up to 99%, although the bacterial population, primarily Staphylococci, rebounded quickly to their pre-disinfection levels.[13] Antimicrobial treated surfaces can suppress the growth of microorganisms, ultimately keeping products and equipment cleaner.[14]

How Antimicrobial Technology is Incorporated in Healthcare Products Today

Antimicrobial protection can be applied to hard surface products in two different ways:

- It can be built-in during the manufacturing process, becoming part of the molecular structure of the product, or
- It can be applied to the surface of the product after manufacture.

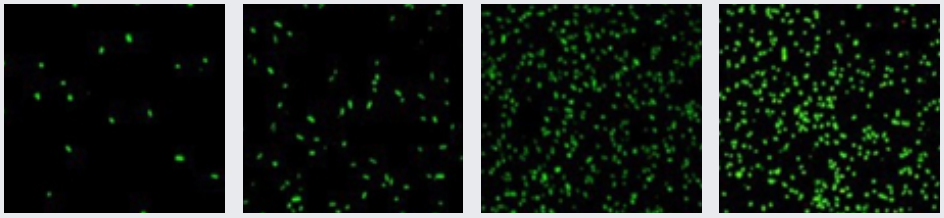
There are advantages in adding protection at the manufacturing stage over a surface application:

- First, the antimicrobial ingredient is evenly dosed throughout the entire treated part or object and damage to the surface will not disturb the preservative's functionality, making for extremely durable and robust product protection
- Second, incorporating antimicrobial protection into the production process is very simple. Additive pellets can be mixed with the raw materials, making them easier to incorporate.

Figure 3 depicts two surfaces – one unprotected and one that was treated with antimicrobial protection –over a 24-hour period. The significant reduction on the antimicrobial treated surface is evident.

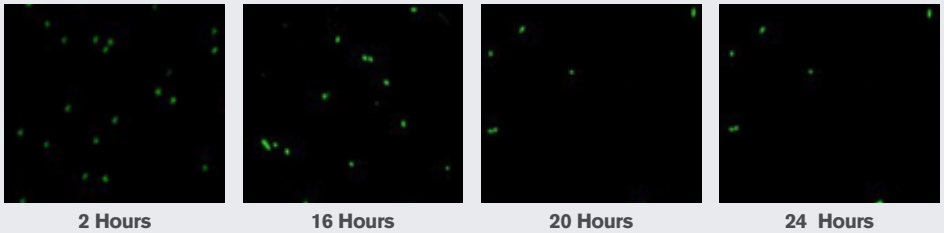
Figure 3

Unprotected Surface



2 Hours | 16 Hours | 20 Hours | 24 Hours

Surface Treated with Antimicrobial Protection



2 Hours | 16 Hours | 20 Hours | 24 Hours

continued >>>

CASE STUDY [15]

In 2006, Clemson University demonstrated that antimicrobial treated construction materials reduced bioburden (i.e., the amount of bacteria) and improved air quality in a hospital environment. An 18-month study compared treated and untreated hospital wings, including 45 surfaces and 10 air sites. The results showed a greater than 80% reduction in bacterial counts on high-touch surfaces such as computer keyboards, mice, and telephone handsets. Wall paint, floor tiles, and ceiling tiles demonstrated an average reduction in bioburden of 40%, with some surfaces demonstrating up to a 91% reduction. Antimicrobial air filters improved air quality in the treated hospital wing by reducing airborne microorganisms by 58%, including a 63% reduction in airborne fungi.

Misconceptions about the Use of Antimicrobials in Products

Despite the benefits of using antimicrobial products, some common misconceptions still remain, such as:

- Built-in antimicrobials can wash off of products and ultimately end up in the water supply. This is false. Incorporated antimicrobials are thoroughly bound in place by the polymer matrix. This encapsulation keeps the antimicrobial in place for the life of the treated article.
- The use of equipment with built-in antimicrobial protection contributes to the development of antibiotic-resistant bacteria. This is false. Antibiotics are a type of antimicrobial that act upon very specific areas of the microbial cell. The specificity of the antibiotic to one cell component makes the development of resistance fairly easy for microbes that can reproduce within minutes and hours. However, built-in antimicrobials are able to target multiple organisms and sites on those organisms, making the development of resistance difficult.
- Equipment with built-in antimicrobial product protection does not have to be cleaned. This is false. Built-in antimicrobials are designed to make cleaning more effective and to control microbial buildup on a surface, but in no way are they designed to replace standard cleaning protocols.

REGULATORY AGENCIES

Antimicrobials have three broad uses:

- Therapeutic agents;
- Surface disinfectants, sanitizers, and pesticides; and
- Material preservatives.

All antimicrobial agents and their uses are regulated and require registration or approval before they can be marketed or used.

Therapeutic uses of antimicrobials are under the jurisdiction of the U.S. Food and Drug Administration (FDA).

Disinfection, sanitizers and material preservatives all fall under the jurisdiction of the Environmental Protection Agency (EPA).

In particular, treated articles making preservation claims fall under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Antimicrobials used in this manner can make material preservation claims but cannot make health claims. All EPA-registered antimicrobials have a use label registered with the EPA, including specific directions on the ways in which the technology must be used in order to make to make the standard FIFRA claims. It is through these labeling and registration processes that the EPA makes sure that the antimicrobial applications are both safe and effective.

continued >>>

IN SUMMARY

There are three types of microorganisms important in the healthcare environment: bacteria, fungi, (mold, mildew, and yeast) and algae. Many types of microorganisms are beneficial to the environment and your body; it is only when they are found outside of their natural habitat that they can be problematic. Healthcare-associated infections are a major source of morbidity, mortality, and increased costs of care throughout the U.S. In addition, the CDC estimates that 80% of all infections are caused by touch. There is a growing need for antimicrobial additives that help protect transport and storage equipment from the growth of bacteria, mold and mildew in the healthcare environment. Antimicrobials can address the problems of degradation, staining, and odor by helping to control microbial growth on surfaces; they can be infused into products during the manufacturing process and will not wear off or wash away. All claims must be adequately qualified so that it is clear that the protection afforded by the antimicrobial additives applies only to the article itself, is not designed to protect the users of the products from disease-causing microorganisms, and is not a substitute for normal cleaning and hygiene practices.

REFERENCES

1. Klevens RM, Edwards JR, Richards CL Jr, et al. Estimating health care- associated infections and deaths in U.S. hospitals, 2002. Public Health Rep. 2007;122(2):160-166.

2. Centers for Disease Control and Prevention. HAI data and statistics. https://www. cdc.gov/hai/surveillance/index.html. Accessed February 19, 2017.

3. Magill SS, Edwards JR, Bamberg W, et al. Multistate point-prevalence survey of health care-associated infections. N Engl J Med. 2014;370(13):1198-1208. http:// www.nejm.org/doi/full/10.1056/NEJMoa1306801#t=articleResults. Accessed February 19, 2017.

4. Scott RD. The direct medical costs of health care-associated infections in US hospitals and the benefits of prevention. https://www.cdc.gov/hai/pdfs/hai/scott_ costpaper.pdf. Accessed February 19, 2017.

5. NewsMax. 80 percent of infections spread by hands: CDC. http://www.newsmax. com/Health/Health-News/infections-hand-fist-bump/2014/01/09/id/546258/. Accessed February 19, 2017.

6. Microbes and infectious disease. http://uhaweb.hartford.edu/bugl/Microbes.pdf. Accessed February 22, 2017.

7. Microbes and infectious disease. http://uhaweb.hartford.edu/bugl/Microbes.pdf. Accessed February 22, 2017.

8. Centers for Disease Control and Prevention. Gram-negative bacteria infections in health care settings. https://www.cdc.gov/hai/organisms/gram-negative-bacteria. html. Accessed February 22, 2017.

9. Centers for Disease Control and Prevention. Klebsiella pneumoniae in health care settings. https://www.cdc.gov/hai/organisms/klebsiella/klebsiella.html. Accessed February 22, 2017.

10. Fungus. https://en.wikipedia.org/wiki/Fungus. Accessed February 22, 2017.

11. Mildew. https://en.wikipedia.org/wiki/Mildew. Accessed February 22, 2017.

12. Mold vs mildew differences. http://www.mold-advisor.com/mold-vs-mildew.html. Accessed February 22, 2017.

13. Attaway HH, Fairey S, Steed LL, Salgado CD, Michels HT, Schmidt MG. Intrinsic bacterial burden associated with intensive care unit hospital beds: effects of disinfection on population recovery and mitigation of potential infection risk. Am J Infect Cont. 2013; 40(10): 907-9012.

14. The benefits of antimicrobial technology in health care facilities. http://www. homscales.com/company/blog/benefits-antimicrobial-technology-healthcare- facilities. Accessed February 22, 2017.

15. McNiece GM, Tyler OZ, Blackhurst DW. Antimicrobial treated construction materials and air filters reduce facility bioburden and improve air quality in a health care environment. In: Pandley M, Xie WC, Xu L, eds. Advances in Engineering Structures, Mechanics and Construction. New York, NY: Springer-Verlag; 2006:841-851.

PROTECTION THAT LIVES ON MICROBAN

1.800.992.1776 www.metro.com

METRO®

We put space to work.®

LO7-152

an Ali Group Company

ALI GROUP

The Spirit of Excellence