Using Disinfectants to Help Reduce the Risk of Infection

Volume 1: Evidence for need of disinfection and following label directions

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1 contact hour
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Using Disinfectants to Help Reduce the Risk of Infection

*Volume 1: Evidence for need of disinfection and following label directions*

This course discusses several studies which demonstrate the survival of bacteria in the environment and the role that surfaces in the hospital play as reservoirs of infection.

While disinfection is an important factor in helping to prevent hospital-acquired infections, hand hygiene is emphasized as the biggest influence in reducing the risk of infection.
The EPA registered chemical disinfectant label has valuable safety and efficacy information. Using the recommended use-dilution of the disinfectant is extremely important. Likewise, understanding the relative shelf-life stability of diluted product in different containers (mop bucket, spray bottle) is important in helping to prevent inadequate disinfection.
About the Author

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Kirsten Thompson is a Principal Technical Specialist for the Healthcare Technical Affairs group of Ecolab’s Professional Products Division. Ecolab Professional Products provides Huntington Brand infection prevention products to the acute and alternate healthcare markets. A microbiologist by training, Ms. Thompson is routinely involved in trouble-shooting and addressing infection prevention questions, providing technical literature and in educating sales personnel and customers concerning microbiological issues.

Learning Objectives

Upon completion of this course, the learner will be able to:

1. Discuss the importance of environmental disinfection to help reduce contamination.
2. Describe how disinfection is a part of an overall system to prevent hospital acquired infection.
3. List the relevant cleaning procedures.
4. Describe the importance of proper dilution of disinfectants.
5. Describe the elements of a training program within a facility.
Environmental Sanitation

Very few people would question the importance of providing a clean and disinfected environment for patients. Environmental sanitation is both sensible and controllable. However, substantiating this practice through scientific study presents a puzzling task. Initially, pathogenic microorganisms from human sources were shown to exist on inanimate objects, such as countertops and floors, through microbiological culturing techniques.

To understand better the epidemiological significance of these findings, researchers have studied the survival of select pathogenic bacteria on dry surfaces to try to determine potential for infection transmission.
Contamination

More than 30 years ago, it was reported that $10^6$ cells of a $10^8$ initial population of Staphylococcus aureus remained alive for 90 days on cotton lint. Ten years ago, it was demonstrated that a large percent of methicillin-resistant Staphylococcus aureus (MRSA), other gram positive cocci and select gram-negative bacilli (*Acinetobacter calcoaceticus* var. *anitratus*) remained viable for 25 days under dry conditions. Many other pathogens, including vancomycin-resistant enterococci (VRE) and the Hepatitis B virus can survive in the environment for extended periods of time. If pathogenic organisms are present and able to survive on surfaces for a length of time, then demonstrating a relationship between the contamination level and infection rate would seem elementary. However, studies that have examined these relationships have produced mixed results.

Relatively little evidence exists that clearly identifies inanimate environmental contamination as an important facet of infection control. This has led many practitioners to base their verdict on circumstantial evidence that environmental disinfection is critical. A study linking an outbreak of Group A streptococcal infection in a long-term care facility to occurrence of this organism in carpet and furnishings provides some of the best evidence to date on how contamination of environmental surfaces can lead to nosocomial infection. This has also been shown to be the case in the domestic environment.

Transfer

The transfer of antibiotic resistant microorganisms such as MRSA and VRE is of great concern in the hospital setting. In addition to concerns regarding hard surface disinfection, “soft” surfaces should also be taken into consideration. One study was conducted to assess the viability of 22 strains of both antibiotic sensitive and resistant Staphylococci and Enterococci on various materials to represent commonly used scrub suits, lab coats, hospital privacy drapes, and splash aprons. All isolates survived for at least one day on these surfaces, and some survived for more than 90 days. Antibiotic resistance or sensitivity seemed to have no impact.
on the survival of the organisms on these fabrics and “soft” surfaces; however, this study also underscores the need to clean the environment thoroughly to prevent fomite transmission of organisms.\textsuperscript{6}

Swab samples of the hospital environment were collected with a focus on computer keyboards and faucet handles.

The colonization rate for keyboards was 26\% in occupied rooms, 24\% in unoccupied rooms. Faucet handles were 15\% in occupied rooms and 11\% in unoccupied rooms. Of the isolates collected, 49\% was MRSA. The same strain of MRSA found in two patients was linked to the faucet handles and keyboards in their respective rooms – as well as other keyboards throughout the ICU, including the doctor’s station. Preventive measures were implemented to include plastic keyboard covers with a daily cleaning protocol and non-contact faucet controls. Not to be forgotten, hand hygiene was also reinforced as a preventive measure.\textsuperscript{7}

Unfortunately, data gaps still exist in pointing the finger conclusively at poor surface disinfection contributing to nosocomial infection. Under routine clinical conditions, failures in hygiene affect more than one variable at the same time. It would be improper to imply that disinfection alone will change nosocomial infection rates, but it is part of an overall system to help prevent hospital-acquired infection. Inanimate objects can be reservoirs of infection, but are not typically modes of infection.
Cleaning Procedures

Hospital cleaning procedures suggest that an EPA registered hospital disinfectant should be used and that the manufacturer’s instructions must be followed. These instructions are written according to the features and limitations of the chemical, including concentrate and use-dilution stability.\(^8\)

The most important information to the end user of a chemical disinfectant is the label use-dilution. It is imperative that disinfectants be diluted properly to effectively clean and disinfect environmental surfaces.

Chemical disinfectant manufacturers must take many factors into account in the formulation of a disinfectant and the determination of the product use-dilution. These factors include:

- The stability of the concentrate and use solution.
- The amount of time in which the product will be used.
- The cost effectiveness for production and for the customer.
- Efficacy at the lowest allowable concentration throughout the shelf-life of the product.

Most recommended hospital cleaning procedures suggest that an EPA registered hospital disinfectant should be used and that the manufacturer’s instructions must be followed. The manufacturer must fully understand the features and limitations of the chemical, including concentrate and use-dilution stability.\(^8\) Many factors influence the efficacy of a disinfectant:

- Active ingredients of the disinfectant.
- Concentration of the disinfectant.
- Exposure time to the disinfectant.
- Temperature and pH of the disinfectant.
- Hardness of the water used as a diluent\(^9\).
Dilution

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Example: TOR II Disinfectant Product Label

Disinfectants that are diluted at a higher concentration than the label recommends can be toxic to individuals and/or the environment. The use of concentrated chemicals may cause skin and lung irritation and/or tissue damage. In addition, some local jurisdictions regulate the disposal of certain chemical germicides by means of the sewer system to minimize environmental harm. High levels of disinfectants have been known to kill the waste-treatment organisms.

By contrast, a concentration of less than the recommended amount can also have deleterious effects by not achieving the proper kill.

A disinfectant diluted at its proper concentration will be effective against all organisms listed on the label, including antibiotic resistant strains. The Center for Disease Control
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(CDC) does not recommend any special strategies or germicides with higher potencies for cleaning non-critical surfaces in rooms of patients who are infected with multiantibiotic-resistant organisms such as vancomycin-resistant Enterococci. An EPA registered germicidal detergent can be used, but remember to read the label to ensure the product list the organisms.\(^1\)\(^2\)

Chemical manufacturers can formulate some disinfectants to be stable in use solution for extended periods of time. The disinfectant manufacturer should be contacted for a recommendation of the stability of disinfectant use solutions. Although not required by a government agency (unless stated on a label), reputable chemical manufacturers should perform tests to prove microbial efficacy of the use solutions of their chemicals to effectively recommend the shelf-life of a diluted solution. Shelf-life of the diluted solution depends on the type of container in which it is stored and its intended use.

**Working Solutions**

Working solutions are defined as those that are intended for immediate use, such as in a bucket or autoscrubber. These solutions are generally open to the atmosphere and are subjected to heavy soil contamination. The longest shelf life for working solutions is one day, depending on the chemistry of the product and the soil load. Most hospitals change buckets of disinfectant solution every three rooms due to heavy soil load.
Closed Systems

A second scenario is a closed system such as the buddy jug of a dilution system or a clean, empty gallon container.

These solutions are characterized as being sealed from contamination, and are regularly dispensed and refilled. The stability is dependent on the solution not being contaminated by extraneous materials. After the shelf-life of the closed system has passed, the containers must be emptied, rinsed thoroughly and allowed to air dry before being reused. The shelf life for closed system use-solutions can range from 14 to 30 days, depending on the chemistry and storage conditions of the product.
Semi-closed Systems

A third scenario is a semi-closed system such as a hand held spray pump bottle. The solutions are considered sealed from contamination, but are at greater risk of contamination due to the spray nozzle. Again, the stability is dependent on the solution not being contaminated by extraneous materials. After the shelf life has passed, it is imperative that the containers and nozzles are emptied, rinsed thoroughly and air dried before reusing. In most cases, the shelf life for semi-closed use solution is 7 days, depending on the chemistry of the product.

In general, recommendations from manufacturers tend to be conservative, as certain conditions of the use solution are beyond their control. These conditions include: water quality (hardness), storage temperature (whether the products has been frozen and/or exposed to excessive heat), soil load, and storage conditions (UV light, etc.).

Use-dilution accuracy can be verified in a variety of ways. The easiest and most convenient is to invest in a mechanical dilution system. This system is calibrated to deliver the correct dilution of product within a tight range of accuracy. However, as with any piece of equipment, a dilution system must be maintained and checked on a periodic basis to ensure a quality delivery system.
In addition, concentrate bottles and/or pumps are manufactured with built-in measuring devices calibrated for accurate delivery of the concentrate. This is a convenient option for smaller facilities.

Test Kits
A number of test kits are available that can determine the concentration of germicides. These tests kits are in the form of paper strips in which a color change is read, titration kits, and other tests in which a user-friendly colorimetric assay is performed. While these tests are convenient, they are specific to each type of disinfectant, subject to human error and must be carefully performed according to the directions.
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Labels
Disinfectant manufacturers provide labels giving information needed for the use of chemicals. Here you will find (as appropriate):

a. Identification of the product (Brand Name)
b. Active ingredients
c. Directions for use
d. Physical and chemical hazards
e. Health hazards
f. First aid information
g. Storing and handling instructions
h. Basic protective clothing, equipment and procedures that are recommended when working with this chemical
i. Name and address of the manufacturer

It’s important to remember that Labels must not be removed or defaced, identify the material that may be hazardous and warn of hazards in a consistent language.
Efficacy studies provide the information for the directions for use and sites of application (Hospitals, Schools, Bathrooms, etc.). The dilution directions, contact time, temperature, organic challenge, and hard water challenge are documented as part of the efficacy study. To obtain a claim as a hospital use disinfectant, the product must be tested against *Staphylococcus aureus*, *Salmonella choleraesuis*, and *Pseudomonas aeruginosa*. Additional bacteria, as well as fungi and viruses can be added to the label with supporting data under the same conditions as the hospital use disinfectant test.\(^\text{13}\)

In summary, the label directions for use for disinfectants should be read thoroughly. This document has been carefully reviewed by the appropriate government agencies. As with any chemical, misuse of disinfectants can lead to serious consequences. All EPA registered labels state: “It is a violation of Federal Law to use this product in a manner inconsistent with it’s labeling.” The dilution has been carefully chosen by taking into account the product chemistry and stability of the formulation, and the precautionary statements reflect the toxicity of the formula. Reading and following label directions is imperative for a compliant infection control program.
Training

With high employee turnover and oftentimes language barriers, consistent training in proper procedures is key to helping ensure a clean and disinfected environment. It is important to not only teach the procedures, but also indicate WHY the procedures are performed, as the failure to attach importance to some practices leads to complacency and a failure to maintain the high standards expected by healthcare staff and the public.

We work today in a dynamic healthcare environment, where the challenges posed by the emergence of antibiotic resistance add other infection-control problems affect all members of the healthcare team. Training should be available for all new environmental services staff, monitoring of practice and infection-control audit of the environment to help ensure standards of hospital hygiene are raised.13

Summary

It is important to note that hand hygiene is still the most important way to help prevent infection. Part of preventing hand contamination, though, is to clean and disinfect surfaces that are touched. The majority of nosocomial infections are transmitted by healthcare workers with improper hand hygiene.

Routine cleaning and responsibility is important: environmental services typically does the patient room at discharge, nursing has some responsibility while the patient is in the room. All healthcare workers are responsible for helping to protect the patient by proper hand hygiene as well as environmental disinfection.
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