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BEST PRACTICES

Optimizing Disinfectant Application in Healthcare Facilities

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Cleaning and disinfecting surfaces in healthcare facilities is critical to reducing the potential contribution of those surfaces to the incidence of healthcare-associated infections (HAIS), according to the Centers for Disease Control and Prevention (CDC). Cleaning is also the necessary first step of any sterilization or disinfection process, according to the CDC's "Guidelines for Environmental Infection Control in Healthcare Facilities." Cleaning renders surfaces safe, to handle or use by removing organic matter, salts and visible soils, all of which interfere with microbial inactivation. The physical action of scrubbing with detergents and surfactants and rinsing with water removes a large number of microorganisms from surfaces. If the surface is not cleaned before the terminal reprocessing procedures are started, the success of the sterilization or disinfection process may be compromised.

Optimizing each step within the disinfection procedure is key to creating the opportunity for complete disinfection to be achieved and maintained. An important step in the process is the mixing and application of the disinfectant. To be effective, the disinfectant should be mixed and applied to the surface uniformly, according to the directions, and the surface should remain wet for the length of time recommended by the manufacturer.

The selection and use of chemical germicides is another important step. Selection is largely a matter of judgment, and should be based on the germicide characteristics and the job it is expected to do. A number of disinfectants are currently used in healthcare facilities including alcohols, hypochlorites, chlorohexidine, iodophors, hydrogen peroxide, phenolics, and quaternary amines compounds. Large numbers of healthcare facilities are currently using quaternary amines to destroy, inhibit, or prevent the growth of microbes on surfaces in patient rooms.

The primary operative assumption underlying the principle of surface disinfection is that the active ingredients capable of rendering microbes non-functional are being delivered to the surface at the correct concentration. It is, therefore, surprising to find that previously underestimated factors, like the type of cloth used to apply the disinfectant to the surface, can dramatically affect the concentration of quaternary amines delivered to the surface. Optimizing the delivery of active ingredients to the surface is often an overlooked step within the disinfection procedure that should not be ignored.

Characteristics of Quaternary Amines Compounds

Quaternary amines have many advantages over other types of disinfectants. They are stable in storage and odorless. Most importantly, quaternary amines are effective against a broad range of vegetative bacteria and enveloped viruses. Quaternary amines are available in both basic and acidic pH forms. Basic quaternary amines are chosen more often due to the fact that quaternary amines are typically more effective in alkaline solutions than in acidic solutions. It is suggested that as the pH increases, the germicidal efficiency of the quat disinfecting solution also increases. For this reason, basic quat solutions are explored in the study described below.[1]

Methods for Applying Surface Disinfectants

There are various methods for applying surface disinfectants in healthcare environments. This study evaluated two types of systems to allow each wiper type to be studied in an application method typical of its common use.

Type 1: Open-bucket system: This system employs an open bucket in which cotton rags or disposable cellulose-based wipers are submerged into the disinfecting solution and then taken out to wipe down various surfaces in patient rooms and other areas of the hospital. To ensure that the chemical concentration of the disinfectant solution is adequate, a simple paper indicator strip is typically used to check the parts per million of quaternary amines present in the open bucket. However, this practice does not monitor the amount of active quaternary amines present in the liquid deposited from the wiper to the surface.

Type 2: Closed-bucket system with disposable nonwoven spunlace wipers: These disposable cleaning wipers have a fiber preparation which is compatible with quaternary amine chemicals and are typically purchased as a system with disposable bucket dispensers included. A dry roll of these wipers can be put into the bucket; then the cleaning or disinfecting chemical is added to saturate the wipers. The bucket is closed and the saturated wipers are dispensed via a port on the top of the bucket. This type of system avoids the contamination of the wipers and the cleaning solution while in use. Because this is a closed system, exposure to chemical vapors and splashes is reduced.

An important concern that has arisen about the practice of using either cotton rags or disposable cellulose-based wipers with quaternary amine solutions in an open bucket is that these materials may be releasing lower amounts of active quats than is indicated by testing the solution in the open bucket. In contrast, it is also proposed that the closed-bucket system, using treated nonwoven spunlace wipers, may main-

tain a higher active quaternary amine concentration than wipers made of cellulose and cotton used in the typical open-bucket system.

To determine if these hypotheses were valid, a study was conducted to examine the effects of commonly used wiping material substrates on the amount of quaternary amine being released to surfaces for the purpose of disinfection using common industry systems of saturation and methods of disinfection practice.

It is important to emphasize that the systems used for the purpose of this study are different so that each wiper type is used under conditions representative of its common use in healthcare disinfection applications. Obviously, the length of time the wipers are exposed to the chemical and the number of wipers placed in the chemical at one time are significant factors. It is, therefore, apparent that the closed-bucket system creates a significantly more challenging environment with regard to the exposure of the wipers to the disinfectant compared to the open-bucket system because the wipers remain in contact with the quat amine solution for a significantly longer period of time.

Objectives and Testing Materials

The primary objective of this study was to measure the concentration of active quaternary amines extracted from various wiping material substrates over a time period that reflects common use practices. The study was conducted using two leading brands of basic quat disinfectants commonly found in healthcare facilities.

The wipers analyzed were:

- Cotton rags
- Cellulose-based wipers
- Nonwoven spunlace wipers with a fiber preparation intended to yield quat compatibility

The cotton rags and cellulose-based wipers were tested following the standard hospital use protocol for disinfectant solutions saturated in an open bucket. The wipers were dipped to absorb disinfectant solution, and then the disinfectant was applied to a surface. The nonwoven spunlace wiper was used in the closed-bucket system supplied with the product. Ninety wipers were saturated within the system and extracted as they would be for the purpose of surface application. All wipers within the closed bucket were saturated with the quat solution for the entire period of testing.

Methodology

The nonwoven spunlace wipers in the closed-bucket system were compared to the cellulose-based wipers and cotton rags in open-bucket systems over an eight-hour period, comparable to a single work shift in a hospital setting. The study was then extended out to three days to investigate the compatibility of the nonwoven spunlace wiper in the closed bucket over time, as this system provided 90 wipers per roll and lasted much longer than the open bucket of disinfectant fluid with dipped wipers. A conservative rate of using six wipers in the bucket per hour over the course of an eight-hour shift was investigated. Fluid samples were collected from the wipers and tested at predetermined time points to detect active quaternary amines available from the wiper for surface disinfection. Titration methods were employed for the determination of quaternary amine actives in the extraction sample. The test results are reported for the entire experimental time period.

In conducting the study, a quaternary amine solution was prepared based on chemical manufacturer specifications, and duplicate buckets without wipers were used as controls. Fluid from the controls was collected and analyzed over an eight-hour period. Fluid was also removed from the open bucket and tested prior to the removal/dipping of the wipers to establish the effect of the correct concentration of the disinfectant solution at designated time points.

For the closed-bucket system with the disposable nonwoven spunlace wipers, quat samples were taken from three wipers at 10-minute time points to obtain solution for three titration measurements of disinfectant for each extraction. The fluid was extracted from the wipers and immediately collected for quat release measurements, which were taken instantaneously.

For the cellulose-based wipers in the open-bucket system, wipers were submerged in the quaternary solution for five seconds, every 10 minutes. Three wipers were removed at designated time points and the solution extracted for quat release measurements. Steps were taken to ensure that the wiper maintained adequate fluid and was not wrung dry. Measurements were taken instantaneously. There were three titrations completed for each extraction.

Results and Discussion

The study results showed a significant decline in the concentration of basic quaternary amines released when cotton rags or cellulose-based wipers were used in the open-bucket system compared to the nonwoven spunlace wipers with a fiber preparation to enhance quat compatibility in the closed-bucket system. In fact, an immediate drop off of quat release at the time point of zero was noted for both cotton and cellulose-based wipers even though neither material was in continuous contact with the disinfectants in the open bucket. This observation suggests an instantaneous negative interaction between these materials and the disinfectant chemicals tested.

The study findings showed that the initial quat release from cotton was 53 percent lower than the original chemical disinfectant A solution (See Figure 1). Over eight hours, representative of a standard work shift, the quat release from cotton continued to decline rapidly. Prior to the solution being depleted in the bucket, the quat release from the last cotton rag passed through the bucket was 0.83 percent of the original disinfectant concentration. By comparison, the cellulose-based wipers also displayed a sharp reduction in active quat release for chemical disinfectant A. At the conclusion of the eight-hour shift, the average quat release from the cellulose-based wipers was 21.5 percent of the original concentration.

In contrast, the nonwoven spunlace wipers with quat compatibility fiber preparation maintained at least 83.6 percent of the chemical disinfectant A solution concentration for the first eight hours of the study. In extended three-day testing, the nonwoven wipers retained an average of 88.6 percent of the original active concentration.

The results for the chemical disinfectant B are shown (See Figure 2). According to study findings, the initial drop in active quat concentration for cotton wipers was 29.3 percent. This is a significant loss that may be of concern to healthcare facilities using this type of disinfectant and wiping substrate to disinfect critical surfaces. Conversely, the study found that the initial nonwoven spunlace wiper taken from the enclosed bucket of chemical disinfectant B maintained 99.6 percent of the original chemical concentration. In extended three-day testing, the nonwoven spunlace wipers retained an average of 90 percent of the original chemical concentration.

These results suggest that the nonwoven spunlace wipers with a fiber preparation intended to yield quat compatibility would better maintain target disinfectant concentration as compared to cotton rags and cellulose-based wipers, even over a relatively prolonged period of time (See Figure 2).

Practical Applications

The results of this study have major implications for disinfecting practices in healthcare facilities. For example, these results demonstrate that there could be a significant reduction in the release of active quat amine concentration when using cotton rags or cellulose-based wipers when disinfecting patient rooms in healthcare facilities. The consumption of active quaternary amines in these disinfecting practices implies that active disinfecting agents are not always applied to the surface in the ideal concentration to support optimum environmental disinfection. In summary, the nonwoven spunlace wiping material specifically designed to be compatible with quaternary amine disinfectant solutions when used in the supplied closed bucket system was found to maintain the concentration of active quaternary amine disinfectant re-

Figure 1: Chemical Disinfectant A

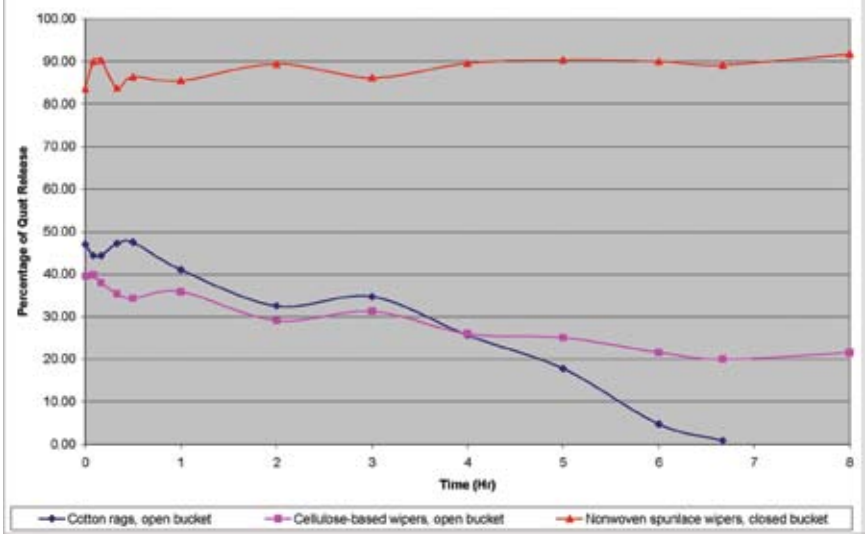
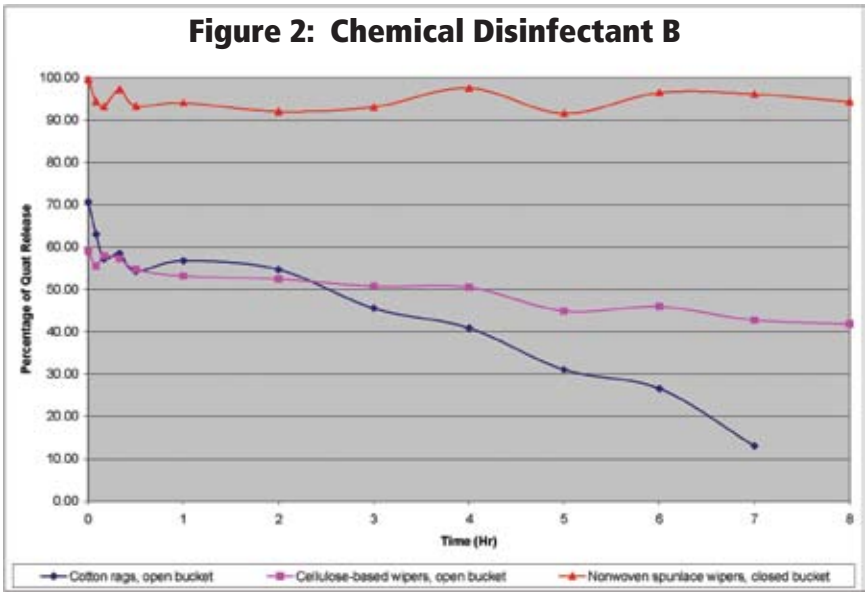


Figure 2: Chemical Disinfectant B



leased to the surface at near target concentration levels. Additionally, the closed-bucket system sustained adequate active concentration in the liquid deposited during wiping for at least a three-day period. The closed-bucket system also prevented potential solution contamination by eliminating any opportunity to re-dip wipers into an open bucket.

Another advantage of this closed system is its versatility, since users can add different types of disinfecting solutions for different tasks in different buckets. The system allows users to more closely control chemical usage and related costs. These closed bucket systems are portable, allowing cleaning crews to spot-clean germ "hot zones" throughout the day without the hassles and inconvenience associated with bringing a full cleaning cart into an occupied space.

In conclusion, healthcare infection control practices can be optimized through the selection of wiping material systems that are compatible with the chemicals used in the surface disinfection protocol. Likewise, some materials currently in use are far from optimal in their ability to provide disinfectant actives to surfaces in the intended concentrations. These findings are important considerations in the design of today's infection control practices. **ICT**

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Reference:

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